Operator manual

Simrad EK500

Fishery research echo sounder

SIMRAD
A KONGSBERG Company

Simrad EK 500
Scientific Echo Sounder

Base version

P2170 / 850-043762 / OPM / 4AA010

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SECTIONS

1 System familiarization

This section contains a description of the system modules of the EK 500 sounder system.

2 Operational procedures

This section describes the man-machine interface, the routines used for switching the system on and off and various operational procedures.

3 Command references

This section gives a detailed description of each of the menu commands and parameters.

4 Maintenance

This section contains information on preventive and corrective maintenance.

5 Technical specifications

This section provides the EK 500 echo sounder system technical specifications.

6 Communication ports

This section describes the telegram types used in the EK 500 system.

7 Theory of Operation

This section contains some of the theory behind the measurements performed by the EK 500; bottom detection, echogram generation, echo integration and target strength statistics.

Appendixes

REMARKS

References

For further information about the system, refer to the following documentation:

EK 500 Installation Manual
EK 500 Maintenance Manual

(The above manuals may have been sent you as an integrated Instruction Manual.)

The reader

This manual is intended for the system operator. It is expected that the operating personnel have prior experience with similar systems, or have completed a Simrad training course.

Notes

This manual holds sections that may be revised individually. In the event of changes to this manual, this "Cover and contents" section will be replaced.

REVISIONS

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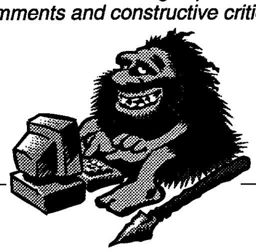
To assist us in making improvements to the product and to this manual, we would welcome comments and constructive criticism. Please send all such, in writing, to:



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1	System familiarization	n/a	4AA010	850-160175	P3558/A
2	Operational procedures	5.20	4AA010	850-160176	P3559/A
3	Command references	5.20	4AA010	850-160177	P3560/B
4	Maintenance	n/a	4AA005	850-130682	P3074/A
5	Technical specifications	n/a	4AA010	850-160178	P3561/A
6	Communication ports	n/a	4AA010	850-160179	P3562/B
7	Theory of operation	n/a	4AA010	850-160180	P3563/A
8	Appendices:				
	Status and error messages	n/a	4AA005	859-043870	P2265/F
	Calibration	n/a	4AA011	859-043867	P2260/E
	ASCII - Hex conversion table	n/a	4AA005	859-043869	P2262/C

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Rev. 1 Software version 2.60.
Rev. 2 New rear panel, changes in section 1 only
Rev. 3 Software version 3.00.
Rev. E Software version 4.01 The layout of the manual has been updated to confirm with Simrad standards.
Rev. F Manual modularized and updated to reflect new software (version 5.20). Refer to EM 10525.
Rev. G Manual changed to software version 5.30

SYSTEM FAMILIARIZATION

P3558 / 850-160175 / 4AA010

This section of the manual describes the hardware for the EK 500 echo sounder system.

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List of contents

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Simrad references

Rev. A First edition as module. Was part of section 1 of P2170E.

1 INTRODUCTION

Simrad has developed special purpose echo sounders for the fisheries research community since the 1950s, and the EK 500 is the fifth generation of equipment within this range. The specifications of this sounder were established in close cooperation with the end users, particularly with the scientists at the Institute of Marine Research in Bergen, Norway.

Accumulated experience combined with utilization of the latest available technology and circuit design has resulted in a sounder with greatly improved performance, and with a number of unique features added fulfilling the requirements of today's and future scientific work.

Basically the EK 500 is a modular triple frequency scientific echo sounder with a high performance and very accurate receiving system and with independent parallel processing within each of the frequency channels. Furthermore, the Simrad EK 500 is the only sounder system which in one compact unit provides:

* *A high performance scientific sounder*
* *An advanced echo integrator*
* *A target strength analyzer (split-beam method)*

A range of single-beam transducers is available at different frequencies. Additionally, dedicated split-beam transducers are available at 18, 38 and 120 kHz for measuring target strength.

A completely new concept is used in the receiver design providing an instantaneous dynamic range of 160 dB. At the same time the absolute amplitude measurement accuracy is very high, and combined with a low self-noise this assures correct measurement of all targets; from individual plankton to a dense school of herring in shallow waters. Note that the receivers are never saturated due to their large instantaneous dynamic range.

The EK 500 includes substantial processing power. Bottom detection, echo integration and target strength algorithms are implemented solely in software with separate computation within each transceiver channel.

Display and printers are available for showing echogram and alphanumeric information. The devices are individually controlled in the sense that echogram range and other presentation parameters are set independently for each device.

The sounder is equipped with powerful data interfaces for connection to external postprocessing and data logging systems.

* An RS232 port is available for simple applications.

* A LAN (Local Area Network) interface of the TCP/IP/ETHERNET type is available for more complex systems.

2 SYSTEM FAMILIARIZATION

2.1 CONFIGURATION

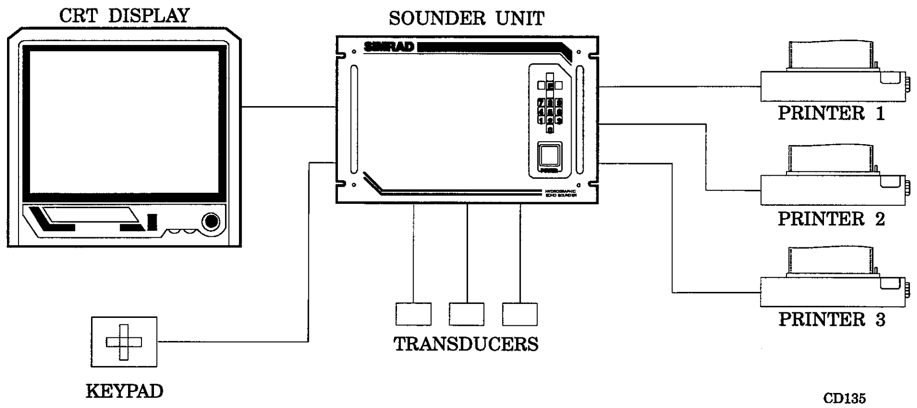

Figure 1 EK 500 system modules.

The EK 500 scientific echo sounder can be configured for single, double or triple frequency operation. Various components contained in a triple frequency delivery are shown in Figure 1.

These are:

* *Sounder unit*
* *Display unit (14" or 20" CRT or 11" LCD)*
* *Keypad for operation (for 20" CRT display)*
* *Transducer(s)*
* *Colour printer(s)*

A separate transducer is used for each transceiver channel, and available operating frequencies are in the range 12 to 710 kHz. Single-beam transducers are available for all frequencies, and split-beam transducers are available at 18, 38 and 120 kHz for target strength measurements.

The sounder is typically connected to a 14" CRT unit with a built-in joystick. Optionally a 20" CRT display unit with a table-mounted keypad or an 11" LCD display are available.

The printers output individually controllable colour echograms and alphanumeric data. Paper width is 210 mm with 720-dot resolution across the paper. Transmitter, receiver, processing and power electronics are all housed in the sounder unit, a rugged and compact unit with mechanical dimensions compliant to the 19" rack standard.

2.2 SIMPLIFIED BLOCK DIAGRAM

Figure 2 shows a simplified block diagram of the sounder unit electronics. Each transceiver channel comprises the following functional modules:

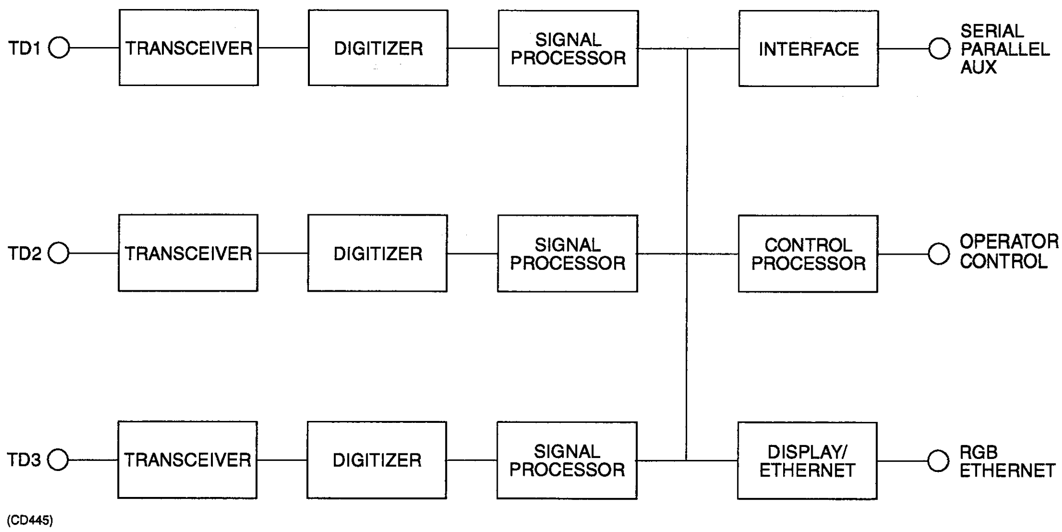

Figure 2 EK 500 simplified block diagram.

* *A transceiver module containing transmitter and receivers*

* *A digitizer module performing A / D-conversion and measurement of electrical phase (applies to split-beam operation only)*

* *A dedicated signal processor implementing algorithms for bottom detection, echogram generation, echo integration, size distribution statistics etc.*

* *A control processor. The signal processor(s) communicates via a common multiprocessor bus with the central control processor. This processor coordinates and synchronizes all activities inside the sounder and handles communications with external devices.*

* *A display / Ethernet module which is controlled by the control processor; the "Display" part generates standard RGB (Red Green Blue) video signals, and the "Ethernet" part contains a LAN interface of the Ethernet type.*

* *An interface module including RS232 serial interfaces, Centronics printer interfaces, analogue input signals and output signal for external transmit synchronization.*

2.3 INTERCONNECTIONS

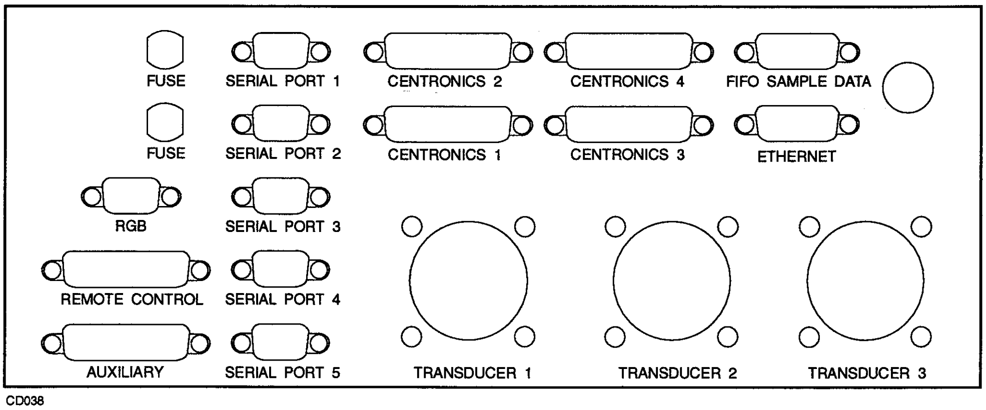

Figure 3 EK 500 rear interconnection panel.

Figure 3 shows the rear panel of the sounder unit. There are five serial ports of type RS232:

Serial port 1:	Remote control and data output
Serial port 2:	Annotation input
Serial port 3:	Navigation data input/NMEA data output
Serial port 4:	Sound velocity probe input
Serial port 5:	Simrad RD remote display output/ trawl input (from serial line A on the ITI trawl instrumentation system)

Printers 1 to 3 are connected to CENTRONICS ports 1 - 3, and the display/joystick/keypad units are connected to the RGB and the REMOTE CONTROL connectors. Centronics port 4 is used for transducer multiplexer operation. The REMOTE CONTROL connector comprises parallel lines for cursor control. The AUXILIARY connector includes a differential analogue input for heave/roll/pitch sensor signals, a log pulse input (from vessel's log) and external transmit synchronization input/output signals. The FIFO SAMPLE DATA connector is for output of sample data within the super layer.

OPERATIONAL PROCEDURES

P3559 / 850-160176 / 4AA010

This section of the manual describes the man-machine interface, gives procedures for switching the system on and off, and includes various operational procedures.

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References

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1 INTRODUCTION

1.1 INTRODUCTION

The display unit normally fitted with the EK 500 echo sounder is a 14" colour display. This unit has a joystick located towards the right side of the front panel, below the display, that is used to control the echo sounder system. Other types of display units may use “Arrow” keys in place of a joystick. Pushing an arrow key will have the same effect as pressing the joystick in the corresponding direction.

1.2 THE JOYSTICK

The joystick enables the operator to move a cursor (a reverse video field) over the desired choices in the menu. Each press up (▴) or down (▾) on the joystick will move the cursor one line up or down in the text. A push to the right (▸) will select the particular parameter, or enter the set value, and return the system to the submenu. Pushing to the left (◂) will exit the parameter or submenu without effecting any changes to the values.

A summary of the commands are:

▴	"Up"	Moves the cursor upwards on the menu or increases value of parameter
▾	"Down"	Moves the cursor downwards on the menu or decreases value of parameter
▸	"Right"	Selects parameter/enters value, and returns system to submenu
◂	"Left"	Exits parameter/submenu without making changes, and returns system to previous menu level.

2 THE DISPLAY AND PRINTER LAYOUT

2.1 THE DISPLAY LAYOUT

The display screen is divided into two main sections; the system menu is displayed towards the left side, and the graphic field (echogram) is displayed towards the right.

The following information will be added to the echogram if the appropriate settings are made in the menu by the operator:

- Layer lines
- Super layer
- Bottom range echogram
- Scale lines
- Integration line
- Event marker
- Bottom lines

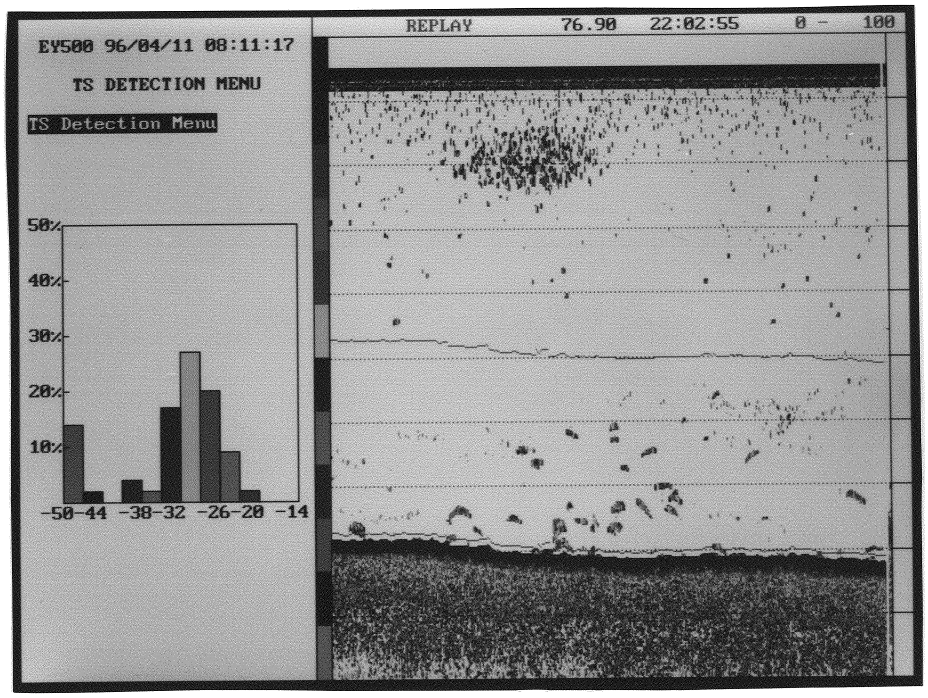

Figure 1 Display echogram

2.2 THE PRINTER LAYOUT

The printer is able to generate a combination of echograms, lines and text. Most elements are controlled by parameters located in the *Printer* menu.

The printer echogram may contain all the information of the display echogram, as well as the additional elements:

- Nautical mile marker
- Annotation
- Date and time
- TS distribution tables
- Integration tables
- Navigation text
- Identification for range, TVG and colour sensitivity

The control of one printer device will have no influence on the other EK 500 output devices. The printer has a graphic resolution of 720 dots, using 12 different colours ranging from blue to red. Black is used mainly on text and separation lines.

The printer may have up to three independent echograms. The echogram number is associated with the transceiver number, hence it will be impossible to print two separate echograms from one transceiver on the same printer.

A typical layout of a printout is shown in figure 2.

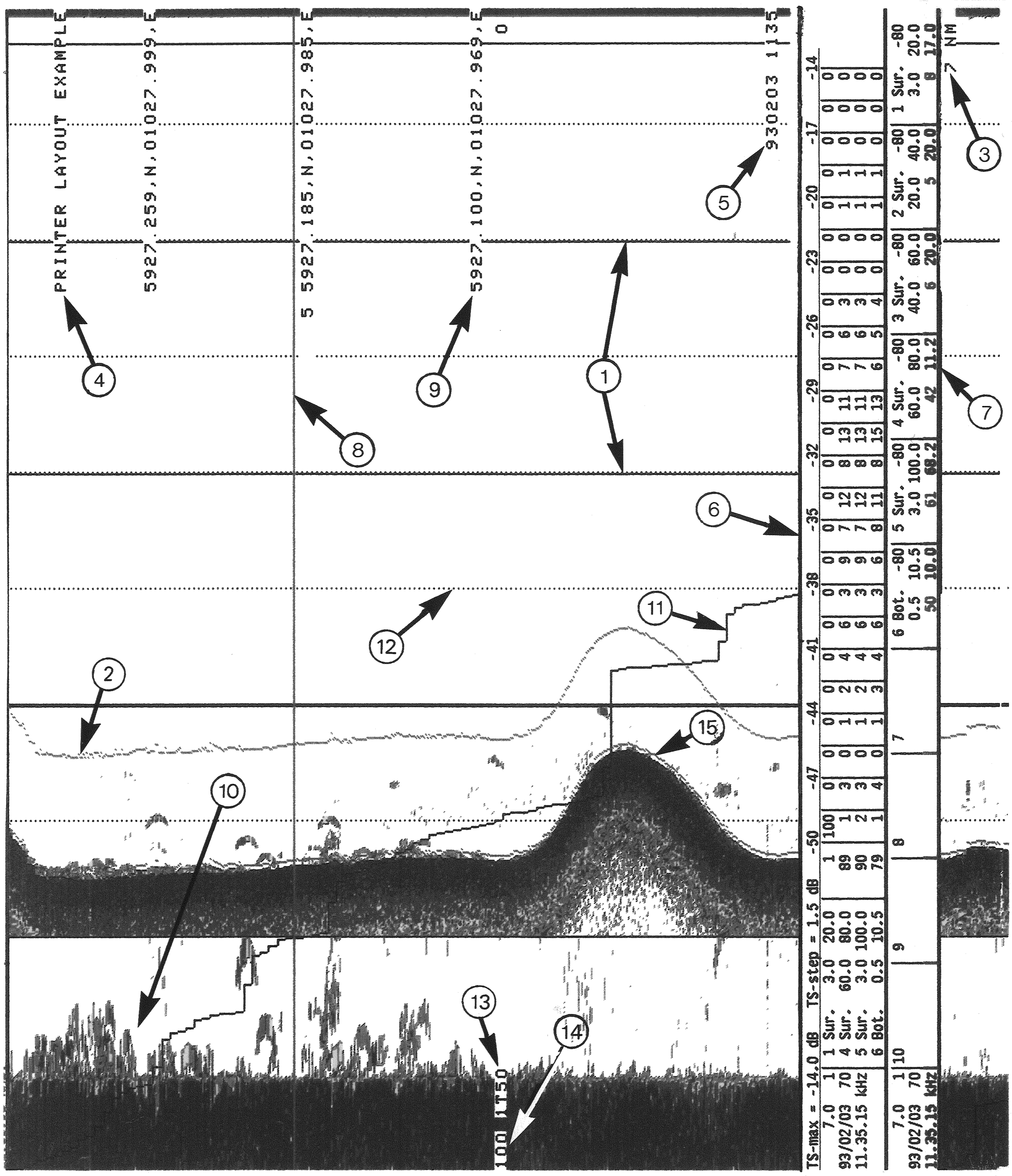

Figure 2 Printer echogram

1 Layer lines	2 Super layer	3 Nautical mile text
4 Annotation	5 Date and time	6 TS distribution
7 Integrator table	8 Event marker	9 Navigation text
10 Bottom range	11 Integrator line	12 Scale line
13 Identification	14 Range lower	15 Bottom line

3 COLOUR SCALE

The colour scale is proportional to the strength of the signals. The echo strength is divided into twelve colour categories, the weakest corresponding to grey and the strongest to brown. The scale is logarithmic with a 3-dB step between each colour, which gives the colour scale a range of 36 dB from the weakest to the strongest echo signal.

In the Echogram submenu it is possible to set the lower limit of the colour scale relative to target strength or volume backscattering strength (the commands *TS Colour Min.* and S_v *Colour Min.*). If, for example, this limit is set to -70 dB, the weakest colour includes the target strength range -70 to -67 dB, while the strongest colour covers the range -37 to -34 dB (-70 dB + 36 dB =-34 dB).

The colour scale is displayed in the echogram.

4 HOW TO SWITCH THE ECHO SOUNDER ON AND OFF

1. Switch on the mains power to the Sounder Unit. The On/Off switch is located on the front side of the unit.

2. Switch on the mains power to the Display Unit. The On/Off switch is located on the front side of the unit.

3. Switch on the mains power to the printer(s).

4. To switch the echo sounder off, reverse the above procedure.

5 HARD RESET

Hard reset is achieved by pressing the joystick to the left when switching on the power. The contents of the RAM will then be reset, and the sounder will come up with the default settings. Hard reset is also achieved by pressing the switch behind the hole marked HR on the Transceiver Unit front when switching on the power.

6 OPERATIONAL PROCEDURES

6.1 INTRODUCTION

The echogram movement across the screen and on the printer is determined by the setting of the *Echogram Speed* parameter (Display Menu and Printer Menu) and the *Ping Interval* (Operation Menu). The echogram colour presentation is mainly influenced by *Colour Gain* and the selected *TVG* (DISPLAY/Echogram Menu and PRINTER/Echogram Menu). If the *Bottom Range Pres.* command is enabled, 20% of the main echogram is overwritten by a bottom-referenced echogram.

Note that, in the following procedures, # denotes transceiver number and @ printer number.

6.2 HOW TO START THE SOUNDER

The following procedure is the minimum required to instruct the echo sounder to start pinging, track the bottom and generate an echogram. In this example it is assumed that only transceiver channel 1 is used.

1 Select the Transceiver menu.

2 Select the Transceiver-1 menu and check that *Mode* is set to *Active.*

3 Select the Display menu and check that *Echogram* is set to *1.*

4 Select the Bottom detection-1 menu and set *Maximum depth* to a value at least as deep as the maximum depth to be expected.

5 Select the Operator menu, and set *Ping mode* to *Normal.*

After a short delay, the sounder will start to ping and an echogram will begin scrolling from right to left on the display.

6.3 HOW TO GENERATE LAYER LINES ON THE DISPLAY AND PRINTER ECHOGRAMS

Set *Layer Lines* in the DISPLAY/Echogram-# /PRINTER-@ /Echogram Menu-# Menu to *On.*

Select the Layer Menu and select *desired Layer.* The Layer-# submenu will then appear, and the parameters in this menu must be selected.

All layer lines for the active layers will be in black colour except for the layer selected as the super layer.

The layer lines have higher priority than echo colour and will overwrite it. The layer type and limits for each layer will determine the layout of the layer picture. The surface layers will only have the lines above bottom visible in the echogram. The bottom layer lines will be written relative to estimated bottom depth.

If the bottom detector fails to find the bottom depth, all the layer lines described above will be absent. However, if the layer type is set to *Pelagic*, the layer lines are always written. In this case the bottom depth is not necessary for successful integration and TS-detection.

6.4 HOW TO SELECT THE SUPER LAYER

One of the layers may be selected in the Layer Menu as a *Super Layer*. The layer selected as super layer will have the layer lines written in red colour instead of black.

The super layer sets the depth limits for controlling several different features in the system:

- TS bar chart on display
- TS detection window on display
- Integration line on display and printer
- Scope presentation.

6.5 HOW TO GENERATE A BOTTOM RANGE ECHOGRAM ON THE DISPLAY AND PRINTER ECHOGRAMS

Select the DISPLAY/Echogram-# Menu (or the PRINTER-@/Echogram-# Menu).

Set the *Bot. Range Pres.* command to *Upper, Bottom* or *Lower*, depending on where you want the Bottom Range to be positioned.

Set *Bottom Range* to the desired range of the bottom echogram.

Set *Bottom Range Start* to the desired the upper start depth of the bottom echogram.

The bottom range echogram is independent of the main echogram. It will overwrite 20% of the main echogram. The bottom range echogram is separated from the main echogram with a solid boundary line. The bottom range echogram is blanked out if no bottom detection has been done.

If *Sub.Bottom Gain* is set above 0.0 dB/m, the bottom range presentation will feature an excess gain below the detected bottom.

6.6 HOW TO GENERATE SCALE LINES ON THE DISPLAY AND PRINTER ECHOGRAMS

Select the DISPLAY/Echogram-# Menu (or the PRINTER-@/Echogram-# Menu).

Select *Scale Lines* and enter the number of equidistant lines you want across the echogram.

6.7 HOW TO GENERATE EVENT MARKERS ON THE DISPLAY AND PRINTER ECHOGRAMS

Select the Display Menu (or the Printer Menu).

Set *Event Marker* to *On.*

The event input may be caused by an external push button or activated by *Event Counter* in the Annotation Menu. The event will result in a red vertical line on the screen and on the printout. The echogram printout will also include the current event number and navigation data.

6.8 HOW TO GENERATE BOTTOM DETECTION LINE(S) ON THE DISPLAY AND PRINTER ECHOGRAMS

The bottom detection line may be introduced for easy marking of the bottom. Each channel has the possibility of displaying the bottom detection line of other channels.

Select the DISPLAY/Echogram-# Menu (or the PRINTER-@/Echogram-# Menu).

Set *Bot. Det. Line* to *any of these combinations: 1, 2, 1&2, 3, 1&3, 2&3, 1&2&3.*

To select which type of sub-bottom presentation you want, set *Presentation* to *Normal, Wh. Line* or *Contour.*

6.9 HOW TO GENERATE AN INTEGRATION LINE ON THE DISPLAY AND PRINTER ECHOGRAMS

Select the DISPLAY/Echogram Menu and enable *Integration Line.* The super layer status must be assigned to one of the layers since the integration line connects to this layer. The deflection line steepness is controlled by the number selected for corresponding S_A value across the echogram paper.

Mode in the Log Menu must be enabled to start integration and thereby causing the integration line to change. The integration line will be reset when log interval or S_A value for one echogram crossing is reached.

The deflection value is updated every sub-log interval (normal = 1/200 nm) in *Speed* mode. In *Ping* mode it is updated for each ping, while in *Time* mode it is updated every 2 seconds.

6.10 HOW TO GENERATE A TS BAR CHART ON THE DISPLAY

Select the Layer Menu and select a *Super Layer.*

Select the TS Detection Menu and check that the *TS Min. Value* corresponds to the lowest TS you wish to be observe.

6.11 HOW TO GENERATE A FISH BEHAVIOUR WINDOW ON THE DISPLAY

Select the Layer Menu and select a *Super Layer.*

Select the TS Detection submenu and check that the *TS Min. Value* corresponds to the lowest TS you wish to be observe..

6.12 HOW TO GENERATE TS DISTRIBUTION TABLES ON THE PRINTER ECHOGRAM

To generate TS distribution tables, select the Printer Menu and set *TS Distribution* to *1.* The table below is generated at log interval detection. To achieve this, select the Log Menu and set *Mode* to the desired log mode.

The layout for the TS distribution results is shown below:

TS-max = -14.0 dB	TS-step = 1.5 dB	-50 -47 -44 -41 -38 -35 -32 -29 -26 -23 -20 -17 -14																								
10.0 1 96/01/23 70 08.31.20 kHz	1 Sur. 3.0 15.0	3	33	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2 Sur. 15.0 30.0	57	7	25	11	54	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3 Sur. 30.0 45.0	84	0	18	8	45	10	6	1	2	5	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	5 Bot. 1.0 11.0	28	0	7	21	29	11	14	0	7	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The header in the table above gives the details about the current TS range in use. The first column underneath on the left side adds information about current log distance, date, time, transceiver channel number and transceiver frequency.

The next column shows the numbers, types and limits for the active layers. Note that the layers without any accepted single fish echoes will be suppressed from this table.

The next column shows the total number of accepted single fish echoes found within each layer. These numbers will give a good indication on the database for the distribution that is given in the next 24 columns.

The numbers in the distribution field is the percentage occurrence in each TS group. The total sum of all groups within each layer should add up to approximately 100 %.

6.13 HOW TO GENERATE INTEGRATION TABLES ON THE PRINTER

The layout for the integration results is shown below:

10.0 96/01/23 70 08.02.23 kHz	10	9	8	7	6	5 Bot. -80 1.0 11.0 92 10.0	4 Sur. -80 45.0 65.0 99 12.3	3 Sur. -80 30.0 45.0 63 15.0	2 Sur. -80 15.0 30.0 219 15.0	1 Sur -80 3.0 15.0 447 12.0

Select the Printer Menu and set *Integr. Tables* to *1.*
The table is generated at log interval detection. To achieve this, select the Log Menu and set *Mode* to the desired log mode.

If a log interval limit is reached, the integration results will be printed across the paper. The format consists of 11 columns where the 10 rightwards columns have identical layout. The left column carries the log distance, date, time, transceiver channel number and transceiver frequency information. The other columns show the following settings and results:

- Layer numbers (1 to 10)
- Layer type (Surface, Bottom, Pelagic)
- Sv threshold
- Lower and upper layer limits referred to surface or bottom
- S_A integration numbers (red colour). Note that the S_a(mean) to be used for fish density calculations is S_a (mean) = $S_A/4\pi$
- Average layer thickness (blue colour)

Note that the average layer thickness will become smaller when a layer is intersected by bottom or transmitter pulse (The margin must also be included).

6.14 HOW TO GENERATE ANNOTATIONS ON THE PRINTER

Select the PRINTER-@/Echogram-# Menu.

Set *Annotation* to *On.*

Annotation messages received will then be printed on the echogram.

6.15 HOW TO PRINT NAVIGATION DATA ON THE PRINTER ECHOGRAM

To get navigation data on the printer a connection between the navigation serial port and the navigation instrument must be established.

Select the Printer Menu and set *Navigation Interval* to a value greater than 0. If the navigation telegram sent to the EK 500 is decoded successfully, the navigation data will be written across the echogram paper. The output rate is controlled by the *Navigation Interval* parameter setting in the Printer Menu.

COMMAND REFERENCES

P3560 / 850-160177 / 4AA010

This document describes the menus and commands in the EK 500 echo sounder. Every option is described in detail.

Note that the command options will vary with the software version. *This description is based on software version 5.30.* If your system operates on a different version, please notify Simrad to have your documentation replaced.

Document revisions

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List of contents

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References

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Rev. B Updated to software version 5.30.

1 INTRODUCTION

Note

This EK 500 Operator Manual is based on software version 5.30. Changes in the software may require amendments to this manual.

The echo sounder is controlled using an interactive menu system. The main menu comprises a list of submenu headings, each of which contains either a list of commands or a further list of submenus. A joystick on the CRT Display Unit (or the "arrow" keys on the LCD Display Unit) is used to move a cursor (inverse video) through the menu, make selections from the menu, and alter the values of the parameters.

When the echo sounder is first switched on, the main menu will be displayed towards the left side of the screen, as shown below:

```
MAIN MENU

OPERATION MENU
DISPLAY MENU
PRINTER MENU
TRANSCEIVER MENU
BOTTOM DETECTION MENU
LOG MENU
LAYER MENU
TS DETECTION MENU
ETHERNET COM. MENU
SERIAL COM. MENU
ANNOTATION MENU
NAVIGATION MENU
SOUND VELOCITY MENU
MOTION SENSOR MENU
UTILITY MENU
TEST MENU
```

When a submenu is selected from the main menu, the main menu will disappear and the submenu text will be displayed instead.

The following chapters and paragraphs describe the submenus and commands, beginning with the first command in the main menu.

2 OPERATION MENU

```
        OPERATION MENU

Ping Mode                 Off
Ping Auto Start           Off
Ping Interval         0.0 sec
Transmit Power         Normal
Noise Margin             0 dB
```

The Operation Menu is used to activate the sounder, to choose if the sounder is to start pinging immediately after being turned on, to set the interval between pings, to select between full power and reduced power and to set the noise margin.

Ping Mode

Options:

Off
Normal
Ext. Trig.

This command enables the echo sounder to operate from either an internal or an external trigger. The command is also used to switch the transmission off.

At power-on this command is set to *Off*, i.e. the sounder is not activated. To start transmitting, either the *Norma*l or the *Ext.trig.* option must be selected.

Normal operation is enabled when this command is set to *Normal*, provided that the transceiver(s) is in the active mode.

Ext.Trig. is used when the sounder is to be triggered by an external pulse.

Ping Auto Start

Options:

Off
On

This command sets the echo sounder to start pinging immediately when switched on. After power on, it will normally be necessary to enter the Operation Menu and set *Ping Mode* to *Normal* to start pinging.

If *Ping Auto Start* is *On* and *Ping Mode* is in any setting other than *Off*, the sounder will start pinging automatically when power is turned on.

Ping Interval

Options:

0.0 to 20.0 seconds in steps of 0.1 second.

This command sets the interval between pings. A fixed ping interval can be set. If the echo sounder is unable to ping as fast as the selected ping interval, a warning will be given, and the ping will be delayed one or more ping intervals. Normal operation is 0.0, i.e. the sounder will ping as fast as possible (only delayed by sound propagation and internal data processing).

Transmit Power

Options:

Normal
Reduced

This command sets the power used during transmission. The transmission power is reduced from its nominal value by 20 dB on all transducer channels by entering *Reduced.* 20 dB down is similar to 1/100 of full power measured in watts.

Noise Margin

Options:

0 to 40 dB in steps of 1 dB

This command enables you to set a noise margin.

The system noise is defined as the sum of receiver noise, local noise and ambient noise. It is continu-

ously estimated during normal operation, and independent computation is performed for each transducer channel. The EK 500 has a continuously increasing transmission loss compensation function included in the software that does not stop at a maximum value. Noise will therefore appear as coloured bands on the echogram when the maximum range of the transducer channel is approached. Consumption of printer ink will then increase considerably. The *Noise Margin* parameter counters this problem. Signal power samples from the receiving system are only forwarded to further processing if their power level exceeds the system noise level plus the *Noise Margin* setting. Thus, with the *Noise Margin* set to *10 dB* most of the noise samples will be disregarded, and only a few noise spikes will appear on the echogram as isolated coloured dots. A Noise Margin of *0 dB* disables the threshold mechanism described. The system noise is defined as the sum of receiver noise, local noise and ambient noise. It is continuously estimated during normal operation based on a precise and relatively robust algorithm.

Note that to observe continuous test signals, the *Noise Margin* must be set to *0 dB*. In general, the noise margin should be kept as low as possible.

3 DISPLAY MENU

```
          DISPLAY MENU

Colour Set               Light
Event Marker               Off
Echogram Speed             1:1
Echogram                     1
Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu
```

The Display Menu is used to choose between different display modes, to introduce an event marker on the display, to select the desired speed of the echogram movement across the screen and to switch the echogram presentation on and off. The Display Menu also contains entry lines for the Echogram submenus.

Colour Set

Options:

Light
Dark
Mono
LCD

This command sets the colour mode for the display. Various display modes can be chosen; light or dark background colour, monochrome, or a video signal which is also suitable for the LCD display unit.

Event Marker

Options:

Off
On

This command enables event markers to be displayed. When *Event Marker* is set to *On*, a vertical line is drawn across the echogram on the display each time an "event" occurs. Refer to paragraph 12, Annotation Menu, for information about how to generate events.

Echogram speed

Options:

1:1	*1:5*
1:2	*1:10*
1:3	

This command selects the frequency at which the pings are displayed. When set to *1:1,* every ping is displayed. Setting *1:2* causes every second ping to be displayed, setting *1:3* causes every third ping to be displayed, etc. Note that this only slows down the display echogram speed; it has no influence on the other output devices.

Echogram

Options:

OFF	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command controls selection and composition of echograms displayed on the screen.

Various combinations of echograms can be displayed on the screen, depending on the number of transducers installed in the vessel.

Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu

Selecting one of these options brings up the Echogram submenu. There are three of these submenus, one for each echogram. The heading of the submenu denotes which echogram menu is chosen.

3.1 DISPLAY/ECHOGRAM-# MENU

DISPLAY/Echogram-# Menu	
Transd. Number	1
Range	100 m
Range Start	0 m
Auto Range	Off
Bottom Range	10 m
Bot. Range Start	5 m
Bot. Range Pres.	Off
Sub. Bottom Gain	0.0 dB/m
Presentation	Normal
TVG	20 log R
Scale Lines	10
Bot. Det. Line	1
Trawl Lines	Off
Layer Lines	Off
Integration Line	Off
TS Colour Min.	-50 dB
Sv Colour Min.	-70 dB

= Transceiver number.

The DISPLAY/Echogram Menu is used to choose the desired echogram presentation on the screen.

Transd. Number

Options:

1 to 32

This command is used to select which transducer echogram is to be displayed. This command applies only to a multiplexed system where more than one transducer is used with one channel. It is only effective when *Sequence* in the Transceiver Menu is *On*.

Range

Options:

1 m	*250*
5 m	*500 m*
10 m	*750 m*
15 m	*1000 m*
25 m	*1500 m*
50 m	*2500 m*
100 m	*5000 m*
150 m	*1000 m*

This command sets the depth range across the main echogram.

Range Start

Options:

0 to 10,000 meters in steps of 1 m

This command sets the upper start depth for the part of the main echogram to be displayed. The parameter value is only significant while *Auto Range* is set to *Off*.

Range Start is similar to "manual phasing" of the range.

Auto Range

Options:

Off
On

This command switches on and off the *Auto Range* function. *Auto Range* provides automatic adjustment of the *Range Start* value, so that the bottom echo is maintained inside the echogram. If *Auto Range* is set to *On*, the *Range Start* value will have no significance. The *Auto Range* function is similar to “automatic phasing” of the range.

Bottom Range

Options:

0 to 100 m in steps of 1 m.

This command sets the range of the bottom echogram. *Bottom Range* defines an "expanded area", a part of the echogram the user may want a closer look at.

Bot. Range Start

Options:

-100 m to +100 m in steps of 1 m.

This command sets the upper start depth of bottom echogram relative to detected bottom depth. Positive values will be above the bottom and negative values will be below the bottom. This is the starting point for "expanded area".

Bot. Range Pres.

Options:

Off
Upper
Bottom
Lower

This command selects where the bottom echogram is to be positioned. *Upper* will locate the area in the upper part of the display. *Lower* will locate it within the lower part. *Bottom* will position the area immediately below the bottom's digitized line.

Sub. Bottom Gain

Options:

0.0 to 5.0 dB/m in 0.1 dB/m steps.

This command adds an extra gain to the sub-bottom echoes, and may improve visual presentation of sub-bottom echoes. When set to *0.5 dB/m*, an extra gain of 0.5 dB per meter below the detected bottom is added to the TVG to compensate for absorption in the bottom.

Presentation

Options:

Normal
Wh. line
Contour

This command affects the presentation of the sub-bottom part of the echogram. In *Normal* mode the echo signal is continuously recorded as received by the transducer.

White line presentation introduces a small gap in the echogram below the detected bottom in order to improve observation of targets close to the bottom.

Contour presentation causes the echogram below the detected bottom to be blanked.

TVG

Options:

20 log R
40 log R

This command controls which transmission loss compensation algorithm is to be used (TVG = Time Variable Gain). 20 log R is selected for echogram presentation of volume back-scattering strength, and 40 log R for presentation of target strength.

Scale Lines

Options:

0 to 250 lines in steps of 1

This command enables you to set the number of scale lines to be displayed. These equidistant scale lines across the echogram simplify interpretation of the echogram.

Bot. Det. Line

Options:

OFF	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command adds bottom detection line(s) to the echogram. *Bot. Det. Line* can be added to the echogram as a verification of where the system defines the true bottom to be. Each channel has the option to implement the *Bot. Det. Line* from other channels.

Trawl Lines

Options:

Off
On

This command adds trawl lines in the echogram. This information is received from serial line or Ethernet. (See section "Communication ports").

Layer Lines

Options:

Off
On

This command allows you to include layer lines in the echogram. The selected super layer lines have red colour, and all other layer lines are black.

Integration Line

Options:

Off	
10	*10000*
100	*100000*
1000	*1000000*

This command allows you to plot the echo integration buildup within the super layer as a deflection line. The numeric setting determines the vertical range across the echogram in units of m^2/nm^2. Refer to the chapter on "Echo integration" in section "Theory of operation".

TS Colour Min.

Options:

-100 to 0 dB in steps of 1 dB

This command sets the lower limit of colour scale relative to target strength. If for example this parameter is set to –50 dB, the lowest TS visible on the display will be –50 dB (grey colour).

Sv Colour Min.

Options:

-100 to 0 dB in steps of 1 dB

This command sets the lower limit of colour scale relative to volume backscattering strength. If for example this parameter is set to –70 dB, the lowest S_v visible on the display will be –70 dB (grey colour).

4 PRINTER MENU

The Printer Menu is used to choose the desired presentation of echogram and data on the printer printout. When the Printer Menu is accessed, a submenu containing three options is displayed as shown below:

```
        PRINTER MENU

Printer-1 Menu
Printer-2 Menu
Printer-3 Menu
```

The three submenus contain similar parameters, the only difference is in the headings. When one of the commands is selected, a further submenu is displayed as shown below:

```
       PRINTER-@ MENU

Model Type            PaintJet
Navig. Interval              0
Event Marker               Off
Annotation                 Off
Naut. Mile Marker          Off
TS Distribution            Off
Integr. Tables             Off
Echogram Speed             1:1
Echogram                   Off
Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu
```

@ = Printer 1/2/3

The Printer Menu is used to choose the desired presentation of echogram and data on the printer printout.

Model Type

Options:

PaintJet
DeskJet

This command is used to select between printer types.

The echogram layout for the two printers are identical except that the DeskJet does not have continuous paper feeding. To indicate the sequence of the echogram, the DeskJet puts the page number and the time information on the top of each page. NB! Please notice that the use of the eject key on the DeskJet printer will result in black and white printing. Instead re-enter Model Type to empty the buffer and eject the page.

Navig. Interval

Options:

0 to 1000 in steps of 1

This command sets the number of incoming navigation telegrams to the sounder per printout on the printer. If, for example, the telegrams are coming in every second and the *Navig. Interval* is set to 60, the system will generate a printout every minute. No navigation data will appear on the printer when the *Navigation Interval* is set to 0.

Event Marker

Options:

Off
On

When this command is set to *On,* a vertical line is drawn across the echogram each time an "event" occurs. Refer to paragraph 12, Annotation Menu, for information about how to generate events.

Annotation

Options:

Off
On

When this command is set to *On*, annotation messages received will be printed on the echogram.

Nautical Mile Marker

Options:

OFF	*ON*

When this command is set to *On*, every nautical mile will be indicated on the echogram paper based on the vessel log counter. A vertical line is drawn across the paper, and the sailed distance is shown along this line.

TS Distribution

Options:

OFF	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command is used to select printout of TS distribution tables.

Integr. Tables

Options:

OFF	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command is used to select printout of echo integration tables.

Echogram Speed

Options:

1:1
1:2
1:3
1:5
1:10

This command selects the frequency at which the pings are printed. When set to *1:1,* every ping is displayed. Setting *1:2* causes every second ping to be printed, setting *1:3* causes every third ping to be printed, etc. Note that this only slows down the display echogram speed; it has no influence on the other output devices.

Echogram

Options:

OFF	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*
	Slave

This command is used to select the echograms to be printed out. When *Slave* is selected, the echogram(s) printed will be those set on the display.

Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu

Selecting one of these options brings up the Echogram submenu. There are three of these submenus, one for each echogram. The heading of the submenu denotes which echogram menu is chosen.

4.1 PRINTER-@/ECHOGRAM-# MENU

```
PRINTER-@/Echogram-# Menu

Transd. number              1
Range                   100 m
Range Start               0 m
Auto Range                Off
Bottom Range             10 m
Bot. Range Start          5 m
Bot. Range Pres.          Off
Sub. Bottom Gain   0.0 dB/m
Presentation           Normal
TVG                20 log R
Scale Lines                10
Bot. Det. Line              1
Trawl Lines               Off
Layer Lines               Off
Integration Line          Off
TS Colour Min.         -50 dB
Sv Colour Min.         -70 dB
```

@ = Printer number.
# = Transceiver number.

The PRINTER/Echogram Menu is used to choose the desired echogram and data presentation on the printout. There are three identical submenus in this group, each one servicing one of the echograms available to be printed.

Except for the parameter *Scope* in the *Presentation* submenu, the commands are identical to those in the DISPLAY/Echogram Menu, and the descriptions are not repeated here. For descriptions, refer to paragraph 3.1.

Presentation

Options:

Normal
Wh. line
Contour
Scope

For descriptions of *Normal, Wh. line* and *Contour*, see paragraph 3.1.

The *Scope* presentation is intended for special purpose studies of the echo return and causes an oscilloscope-like plot of a single ping to be printed.

Echo amplitude and directional angles are plotted; echo amplitude in units of dBW (referred to the transducer terminals) and directional angles in units of phase steps (64 phase steps = 180 electrical degrees). The plot starts at the *Range Start* setting, and a total of 300 samples (basic hardware sampling rate of transceiver) is plotted. Note that no echogram is plotted during the printout period.

For the rest of the commands, refer to descriptions under paragraph 3.1.

5 TRANSCEIVER MENU

```
        TRANSCEIVER MENU

Transceiver-1 Menu
Transceiver-2 Menu
Transceiver-3 Menu
```

Transceiver-1 Menu
Transceiver-2 Menu
Transceiver-3 Menu

Selecting one of these options brings up the Transceiver submenu. There are three of these submenus, one for each transceiver in the system. The heading of the submenu denotes which transceiver is chosen.

5.1 TRANSCEIVER-# MENU

```
Transceiver-# Menu 38 kHz

Mode                     Active
Transducer Type           ES38B
Transd. Sequence            Off
Transducer Depth         0.00 m
Absorption Coef.        10 dBkm
Pulse Length             Medium
Bandwidth                  Auto
Max. Power               2000 W
2-Way Beam Angle       -20.6 dB
Sv Transd. Gain        26.50 dB
TS Transd. Gain        26.50 dB
Angle Sens.Along           21.9
Angle Sens.Athw.           21.9
3 dB Beamw.Along         7.1 dg
3 dB Beamw.Athw.         7.1 dg
Alongship Offset         0.0 dg
Athw.ship Offset         0.0 dg
```

= Transceiver number.

The Transceiver-# Menu is used to set important receiver and transmitter parameters. Some of these parameters depend on the transducer type, and are listed in the "Technical specifications" section of this manual.

The transceiver in the EK 500 has a unique signature corresponding to its frequency and type (single or split beam). When the power is switched on, the EK 500 will read this signature and fetch the parameters corresponding to the installed transceiver. The above Transceiver Menu shows the default parameters of a 38 kHz transducer.

The different transducer types that operate on the same frequency use the same transceiver, but may require different nominal values for 2-Way Beam Angle and Transducer Gain parameters. Refer to the Installation Manual for details concerning installation of an extra transceiver kit.

If a non-Simrad transducer is installed, the relevant parameters must be obtained from the transducer supplier.

Mode

Options:

Off
Active
Passive
Test

This command sets the transceiver operating mode. The transceiver channel is either *Off, Active* (normal operation), *Passive* (the transmitter is disabled) or in *Test* mode (a test signal is inserted in the receiver front end, the transmitter is disabled).

Transducer Type

Options

*

This command introduces a list of transducers depending on the signature read from the transceiver. The transducer type connected to the system should be selected. When set to *Other,* the operator may enter the relevant specifications if a non-standard transducer is to be used.

Transd. Sequence

Options:

Off
On

This operation requires special hardware supplied by Simrad. Up to 32 transducers per transceiver can be used in a multiplexing scheme.

The procedure for *Transd. Sequence* is:

Set *Transd. Sequence* to *On*

This brings forth the following submenu:

Number	1
State	On
No. of Ping	1
Depth	0.00 m

Number is the transducer number and may be set from 1 to 32.

State will enable the transducer for sequencing if *On* and disable the transducer if *Off*.

No. of Ping is set to the number of pings before moving to the next transducer in the sequence.

Transducer *Depth* may be set for each transducer according to the physical system setup.

Note that the transducer type and transducer parameters may be set individually for each transducer number.

Transducer Depth

Options:

0.00 to 999.99 m in steps of 0.01 m

This command sets the installation depth of the transducer. The transducer will never be installed exactly on the water-line. The installation depth must therefore be input to enable the system to add the difference in depth between the transducer face and the water surface.

Absorption Coef.

Options:

0 to 300 dB/km in steps of 1 dB/km

This command sets the local absorption coefficient. The default value is computed according to: Francois and Garrison, J. Acoust. Soc. Am. 72(6), December 1982.

* 10 degrees Celsius
* 35 parts per thousand salinity
* 250 meter depth
* pH = 8

Pulse Length

Options:

Short
Medium
Long

This command selects the pulse length (pulse duration) for the transmitted signal. The user may select between three different pulse lengths. The exact pulse lengths of the transmitted pulses are given in the "Technical specifications" section of this manual.

Bandwidth

Options:

Narrow
Wide
Auto

This command sets the bandwidth for the transceiver. The user may select between *Wide* and *Narrow* manual bandwidth, or *Auto* for automatic selection.

In *Auto* the bandwidth is automatically adjusted to the pulse length:

- *Wide* bandwidth for *Short* and *Medium* pulse length
- *Narrow* bandwidth for *Long* pulse length.

Note that *Narrow* bandwidth should normally not be used in combination with *Short* and *Medium* pulse length.

Max. Power

Options:

1 to 10,000 W in steps of 1 W

This command sets the maximum transmission power for the system. The setting only affects the value used in the computations, and it should be set according to the installed transceiver board. (The transceiver board controls the transmitted power).

2-Way Beam Angle

Options:

-99.9 dB to 0.0 dB in steps of 0.1 dB

This command sets the equivalent two-way beam angle. This parameter is given by the transducer's characteristics, found in the "Technical specifications" section of this manual. This setting affects the system's computation to establish the correct level of the returned bottom echo. This signal level is used directly to give the echogram correct colours.

Sv Transd. Gain

Options:

0.00 to 99.99 dB in steps of 0.01 dB

This command sets the peak transducer gain assumed during computation of volume backscattering strength.

Refer to chapter "Power budget" in section "Theory of operation".

TS Transd. Gain

Options:

0.00 to 99.99 dB in steps of 0.01 dB

This command sets the peak transducer gain assumed during computation of target strength. Refer to chapter "Power budget" in section "Theory of operation".

Angle Sens. Along

Options:

0.0 to 100.0 in steps of 0.1.

This command sets the angle sensitivity in the fore-and-aft (alongships) direction. Angle sensitivity of split-beam transducer = electrical angle in degrees for one mechanical angle in degrees.

Refer to paragraph "Split beam operation" in section "Theory of operation".

Angle Sens. Athw.

Options:

0.0 to 100.0 in steps of 0.1.

This command sets the angle sensitivity in the athwartships direction. Angle sensitivity of split-beam transducer = electrical angle in degrees for one mechanical angle in degrees.

Refer to paragraph "Split beam operation" in section "Theory of operation".

3 dB Beamw. Along

Options:

0.0 to 99.9 degrees in steps of 0.1 degree.

This command sets the 3 dB beamwidth of transducer in the fore-and-aft (alongships) direction.

Refer to paragraph "Split beam operation" in section "Theory of operation".

3 dB Beamw. Athw.

Options:

0.0 to 99.9 degrees in steps of 0.1 degree.

This command sets the 3 dB beamwidth of transducer in the athwartships direction.

Refer to paragraph "Split beam operation" in section "Theory of operation".

Alongship Offset

Options:

-9.99 to +9.99 degrees in steps of 0.1 degree.

This command sets the mechanical offset angle in the fore-and-aft direction. Refer to chapter "Split-beam operation" in section "Theory of operation"..

Athw.ship Offset

Options:

-9.99 to +9.99 degrees in steps of 0.1 degree.

This command sets the mechanical offset angle in the athwartships direction. Refer to chapter "Split-beam operation" in section "Theory of operation".

6 BOTTOM DETECTION MENU

```
   BOTTOM-DETECTION MENU

Bottom Detection-1 Menu
Bottom Detection-2 Menu
Bottom Detection-3 Menu
```

This menu is used for selection of Bottom Detection submenus. There are three of these submenus, one for each transceiver. The heading of the submenu denotes which transceiver is chosen.

6.1 BOTTOM-DETECTION-# MENU

```
  Bottom-Detection-# Menu

Minimum Depth         0.0 m
Maximum Depth           x m
Min. Depth Alarm      0.0 m
Max. Depth Alarm        0 m
Bottom Lost Al.       Off
Minimum Level        -50 dB
```

= Transceiver number.

The Bottom Detection Menu sets the limits for the bottom detection algorithm. Alarm functions related to the bottom are found here. More details about the bottom detection is found in the paragraph Bottom Detection in the "Theory of operation" section of this manual.

Minimum Depth

Options:

0.0 to 9999.9 m in steps of 0.1 m

This command sets the minimum depth for the bottom detection algorithm.

The system will search for a likely bottom echo, starting from the depth set on this command. If you know that the sea bed is at a depth of roughly 150 metres, some time and processing power can be wasted by requiring the echo sounder to search through all the information returning from the water between the surface and, say, 120 metres depth.

This command therefore enables the bottom detector to ignore all echoes returning from depths of less than the setting.

A setting of *0.0 m* means the system will start searching for a candidate for a bottom echo, from the surface.

Maximum Depth

Options:

0 to 12,000 m in steps of 1 m

This command sets the maximum depth for the bottom detection algorithm.

The system will stop searching for a likely bottom echo at the depth set on this command. If the system looses bottom track, much time can be wasted by requiring the echo sounder to search for bottom echoes at depths far greater than the known depth in the area in which you are working.

The default value depends on the transceiver installed. A depth setting of *0 m* disables the bottom detection algorithm.

This setting is used during the start-up sequence, and each time the system loses the bottom track. The recommended setting is a little deeper than the greatest depth in the area you are working in.

Min. Depth Alarm

Options:

0.0 to 9999.9 m in steps of 0.1 m

This command turns on an alarm if the detected depth is shallower than this setting. When working in unknown waters, this command can be set to provide a warning that the vessel is moving into danger. A depth setting of *0 m* disables the alarm.

Max. Depth Alarm

Options:

0 to 12,000 m in steps of 1 m.

This command turns on an alarm if the detected depth is greater than this setting. A depth setting of *0 m* disables the alarm.

Bottom Lost Alarm

Options:

Off
On

This command turns on an alarm when bottom detection is lost.

Minimum Level

Options:

-80 dB to 0 dB in steps of 1 dB.

This command sets the minimum bottom detection level. After bottom detection, the detected depth is decremented in sample steps until the received echo signal (surface backscattering strength) is below the *Minimum Level* setting.

7 LOG MENU

```
            LOG MENU

Mode                        Off
Ping Interval               100
Time Interval            60 sec
Dist. Interval           1.0 nm
Distance                    0.0
Nm Pulse Rate           200 /nm
```

The purpose of the Log Menu is to set the intervals between each final calculation of Sa and TS values. The intervals can be based on pings, time or distance.

A log distance counter is displayed at the bottom of the menu and is active only in *Speed* mode.

Note that during a log interval it is possible to set the mode to *Off* and then initiate outputs of the log result. This is useful when uneven distance intervals are needed.

Mode

Options:

Off
Ping
Time
Speed
Nm Pulse

The log mode is either *Off*, based on *Ping* or *Time* interval, or *Speed* set in the Navigation Menu. The log mode must be in any position but *Off* in order to get Sa and TS tables. Also the TS distribution bar chart in the TS detection menu needs the log to be operative. Common for all intervals in the Log Menu is the end of a measuring period and the calculation of Sa and TS tables.

The Nm pulse requires 10 or 200 pulses/nm to be input from external log system. See the *Nm Pulse Rate* command description below.

Ping Interval

Options:

10 to 10000 in steps of 1

This command sets the averaging interval (along the path travelled by the vessel). This interval is used by the statistical algorithms and is entered in units of number of pings.

Time Interval

10 to 3600 seconds in steps of 1 second

This command sets the averaging interval (along the path travelled by the vessel). This interval is used by the statistical algorithms and is entered in units of seconds.

Dist. Interval

Options:

0.1 to 10.0 nautical miles in 0.1 nm intervals

This command sets the averaging interval (along the path travelled by the vessel). This interval is used by the statistical algorithms and is entered in units of nautical miles.

Distance

Options:

0 to 9999.9 nm in steps of 0.1 nm.

This command sets the EK 500 internal log distance counter. The counter is typically set according to the vessel's log. The log distance counter is displayed at the bottom of the menu.

Nm Pulse Rate

Options:

200/nm
10/nm

This command sets the pulse rate of the external log unit. It can be either 200 pulses per nautical mile or 10 pulses per nautical mile.

8 LAYER MENU

```
        LAYER MENU

Super Layer
Layer-1 Menu
Layer-2 Menu
Layer-3 Menu
Layer-4 Menu
Layer-6 Menu
Layer-7 Menu
Layer-8 Menu
Layer-9 Menu
Layer-10 Menu
```

Refer to chapter "Layers and averaging interval" in section "Theory of operation" in this manual.

Super Layer

Options:

0 to 10 in steps of 1

This command gives one of the ten layers status as super layer. Various special functions are related to this layer:

- TS bar chart on display
- fish behaviour window on display
- integration line on display and printers
- sample data on FIFO.
- SCOPE on printer and display.

The super layer is shown with red layer lines on the display and the printers. All super layer functions are disabled when set to zero.

The ten layers are specified in the Layer-1 to Layer-10 submenus.

8.1 LAYER SUBMENU

```
          Layer-# Menu

Type                          Off
Range                      50.0 m
Range Start                   x m
Margin                      1.0 m
Sv Threshold               -80 dB
No. of Sublayers                1
```

= 1/2/3

Range start value depends on layer-#.

Type

Options:

Off
Surface
Bottom
Pelagic

This command selects between different types of layers. A layer is either *Off*, referred to the sea *Surface* (bottom detection required for integration and TS measurements), referred to the detected *Bottom,* or *Pelagic* (referred to the sea surface but with no bottom detection required). The pelagic type should be used in deep waters when no bottom is available and when pinging horizontally.

Range

Options:

0.0 to 1000.0 m in steps of 0.1 m.

This command sets the thickness of the layer. Should be minimum two sample intervals.

Range Start

Options:

-10.0 to +9999.9 m in steps of 0.1 m.

This command sets the upper depth limit of the layer. This limit is either referred to the sea surface (positive values below the surface) or to the detected bottom (positive values above the bottom).

Margin

Options:

0.0 to 10.0 m in steps of 0.1 m.

This command causes a surface layer to stop at the margin distance above the detected bottom and a bottom layer to stop at the margin distance below the transducer face. In pelagic layer type this parameter is ignored.

Sv Threshold

Options:

-100 to 0 dB in steps of 1 dB

This command sets the volume backscattering strength threshold value for echo integration. Refer to chapter "Echo integration" in section "Theory of operation".

No. of Sublayers

Options:

1 to 50 in steps of 1

This command makes it possible to divide each layer into a number of equidistant sublayers.

9 TS DETECTION MENU

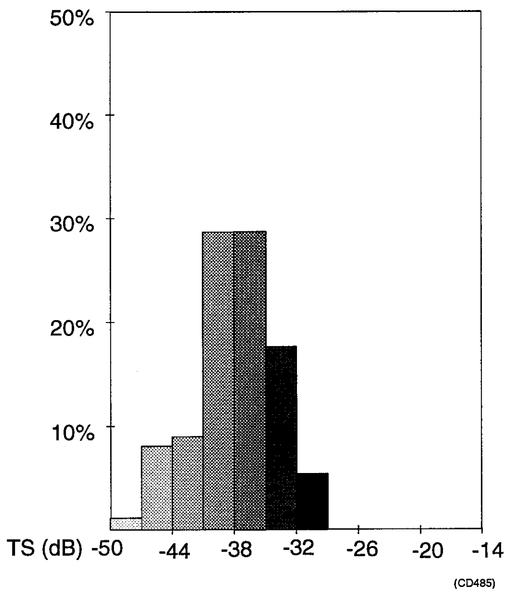
```
TS-DETECTION MENU

TS-Detection-1 Menu
TS-Detection-2 Menu
TS-Detection-3 Menu
```

TS-Detection-1 Menu
TS-Detection-2 Menu
TS-Detection-3 Menu

Selecting one of these options brings up the TS Detection submenu. There are three of these submenus, one for each transceiver channel. The heading of the submenu denotes which channel is chosen.

Single fish detections inside the super layer of the selected transceiver channel is displayed as a TS bar chart, which is updated every log interval. The bar colours correspond to echogram colours only when the *Min. Value* in the TS Detection Menu is equal to *TS Colour Min.* in the Echogram Menu. An example is shown below.



9.1 TS-DETECTION-# MENU

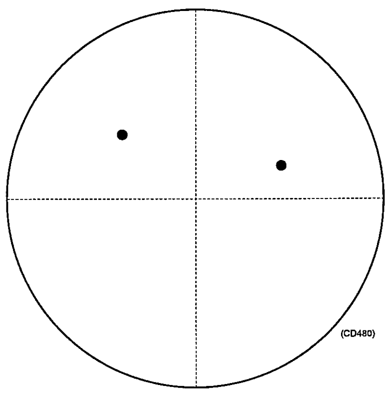
```
      TS-Detection-# Menu

Min. Value              -50 dB
Min. Echo Length           0.8
Max. Echo Length           1.5
Max. Gain Comp.         4.0 dB
Max. Phase Dev.            4.0
```

= transceiver number

Refer to chapter "Split-beam operation" in section "Theory of operation" in this manual.

Single fish detections inside the super layer of the current transceiver channel are displayed in a fish behaviour window. In addition, data related to the strongest single echo is displayed numerically. The figure below shows the position of two fishes in the sound beam, seen from above. Up to 30 fish echoes may be displayed simultaneously. The shape of the fish behaviour window will be either circular or elliptical depending on the transducer selected.



Depth	16.30m
TS compensated	-37.0 dB
TS uncompensated	-39.0 dB
Angle along	0.8 dg
Angle athwart	2.1 dg

Min. Value

Options:

-100 to 0 dB in steps of 1 dB.

This command sets the threshold value for single echo detections. Also lower boundary for the computation of TS distribution classes in the TS tables.

Min. Echo Length

Options:

0.0 to 10.0 in steps of 0.1.

This command sets the minimum echo length. For a single echo detection to occur the normalized echo length (echo length between the 6 dB points relative to the peak value divided by the duration of the transmitted pulse) must exceed this parameter.

Max. Echo Length

Options:

0.0 to 10.0 in steps of 0.1.

This command sets the maximum echo length. A single echo detection requires the normalized echo length to be less than the max echo length setting.

Max. Gain Comp.

Options:

0.0 to 6.0 dB in steps of 0.1 dB.

This command sets the maximum gain compensation. The correction value returned from the transducer gain model must not exceed the max gain compensation setting. (This is the one-way max. gain compensation, the two-way max. compensation will be 12 dB).

All echoes outside the angle corresponding to the chosen gain compensation are skipped. Thus one can reduce the sample volume (beam angle) by choosing a lower value for max. gain compensation.

Max. Phase Dev.

Options:

0.0 to 10.0 in steps of 0.1.

This command sets the maximum standard phase deviation. The electrical phase jitter between samples inside an echo pulse must not exceed the max phase deviation setting where max phase deviation is set in units of phase steps (64 phase steps = 180 electrical degrees).

This parameter controls one of several mechanisms for isolating echoes from single targets. Recommended setting is 2 - 3 for normal conditions. For weak echoes in noisy conditions one should allow more jitter (4 - 10).

10 ETHERNET COMMUNICATION MENU

```
        ETHERNET COM. MENU

Telegram Menu
UDP Port Menu
Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu
Local ETH Addr.
Local IP Addr.
Remote ETH Addr.
Remote IP Addr.
```

The commands and parameters located in the Ethernet Communication Menu enable you to set up the communication ports and addresses as required for your system.

Refer also to the “Communication ports” section of this manual.

Local ETH Addr. Ethernet address of sounder entered as a sequence of 6 bytes.
Default value: *08:00:14:51:57:91.*

Local IP Addr. Internet address of sounder entered as a sequence of 4 bytes.
Default value: *157.237.016.001.*

Remote ETH Addr. Ethernet address of remote host entered as a sequence of 6 bytes.
Default value: *FF:FF:FF:FF:FF:FF*

Remote IP Addr. Internet address of remote host entered as a sequence of 4 bytes.
Default value: *255.255.255.255*

10.1 ETHERNET/TELEGRAM MENU

```
   ETHERNET/Telegram Menu

Remote Control          On
Sample Range           0 m
Status                 Off
Parameter              Off
Annotation             Off
Navigation             Off
Sound Velocity         Off
Motion Sensor          Off
Depth                  Off
Depth NMEA             Off
Echogram               Off
Echo-Trace             Off
Sv                     Off
Sample Angle           Off
Sample Power           Off
Sample Sv              Off
Sample TS              Off
Vessel-Log             Off
Layer                  Off
Integrator             Off
TS Distribution        Off
Towed Fish             Off
```

This menu basically controls the composition of output data telegrams on the LAN port. The commands are related to binary output telegrams and to the UDP/IP/ETHERNET addressing scheme. For details about telegrams, refer to the LAN port chapter in the "Communication ports" section of this manual.

Remote Control

Options:

Off
On

This command enables the system to interpret *(On)* or ignore *(Off)* external remote control telegrams.

Sample Range

Options

0 to 10,000 m in steps of 1

This command sets the range for the sample angle and sample power telegrams. The range must be at least as large as the assumed depth.

The maximum number of samples for each enabled sample telegram is 10,000 values.

Status

Options:

Off
On

This command switches on and off the status, error, warning and alarm output telegrams.

Parameter

Options:

Off
On

This command switches on and off the parameter enter and parameter request output telegram.

Annotation

Options:

Off
On

This command switches on and off the annotation output telegram.

Navigation

Options:

Off
On

This command switches on and off the navigation output telegram.

Sound Velocity

Options:

Off
On

This command switches on and off the sound velocity output telegram.

Motion Sensor

Options:

Off
On

This command switches on and off the heave, roll and pitch sensor output telegram.

Depth

Options:

Off, 1, 2, 1&2, 3, 1&3, 2&3, 1&2&3

This command switches off, or on for the various transceivers, the detected depth output telegram.

Depth NMEA

Options:

Off
1
2
3

This command switches off, or on for the various transceivers, the detected depth output telegram in NMEA format.

Echogram

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the echogram output telegram to be used by advanced postprocessing systems, allowing an entire cruise to be replayed off-line on a general purpose computer.

Echo-Trace

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the echo-trace (single echo detection) output telegram.

Sv

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the Sv output telegram (mean volume backscattering strength per ping within each of the layers).

Sample Angle

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the output telegram containing angle sample data from the transceiver (applies to split beam transceiver channels only). The fore-and-aft and athwartships electrical angles are output as one 16-bit word. All samples (basic sampling rate of transceiver) inside the super layer are output. Sample data is transmitted as one or more data blocks due to the fact that an Ethernet block only can contain data from 727 16-bit samples. For all sample telegrams the maximum number of samples is 10 000.

Sample Power

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the output telegram containing power sample data from the transceiver.

Each power sample is output as one 16-bit word. See the *Sample Angle* description above for additional comments.

Sample Sv

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the sample Sv output telegram containing volume backscattering strength sample data. See the *Sample Angle* description above for additional comments.

Sample TS

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches off, or on for the various transceivers the sample TS output telegram containing target strength sample data. See the *Sample Angle* description above for additional comments.

Vessel-Log

Options:

Off
On

This command switches on and off the vessel-log output telegram. This telegram reports that a log pulse has been detected. Typically, there are 200 pulses per nautical mile.

Layer

Options:

Off
On

This command switches on and off the layer output telegram containing the layer parameter settings every log interval.

Integrator

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches on and off for the various transceivers the integrator output telegram containing echo integration results for every log interval.

TS Distribution

Options:

Off	*3*
1	*1&3*
2	*2&3*
1&2	*1&2&3*

This command switches on and off for the various transceivers the output telegram containing TS distributions for every log interval.

Towed Fish

Options:

Off
On

This command switches on and off the towed fish telegram.

10.2 ETHERNET/UDP PORT MENU

ETHERNET/UDP Port Menu	
Status	2000
Parameter	2000
Annotation	2000
Navigation	2000
Sound Velocity	2000
Motion Sensor	2000
Depth	2000
Depth NMEA	2000
Echogram	2000
Echo-Trace	2000
Sv	2000
Sample Angle	2000
Sample Power	2000
Sample Sv	2000
Sample TS	2000
Vessel-Log	2000
Layer	2000
Integrator	2000
TS Distribution	2000
Towed Fish	2000

This submenu allows the destination UDP port number of each output telegram type to be individually selected.

All the UDP port destination numbers can be set to values between:

0 to 32767 in steps of 1

Simrad recommends that numbers ≥ 2000 are used.

10.3 ETHERNET/ECHOGRAM-# MENU

```
ETHERNET/Echogram-# Menu

Range                        100 m
Range Start                    0 m
Auto Range                     Off
Bottom Range                  15 m
Bot. Range Start              10 m
No. of Main Val.               250
No. of Bot. Val.                75
TVG                       20 log R
```

= Transceiver number.

This submenu contains the commands used to adjust the settings for echograms to be transmitted via the Ethernet port.

Except for the commands *No. of Main Val.* and *No. of Bot. Val.* , the commands are identical to those in the DISPLAY/Echogram Menu, described under paragraph 3.1.

No. of Main Val.

Options

0 to 700 in steps of 1

This command sets the main echogram resolution (the number of main echogram values).

There are certain limitations on the block size of an Ethernet message. For further details, refer to the “Communication ports” section of the manual.

No. of Bot. Val.

Options:

0 to 500 in steps of 1

This command sets the bottom-echogram resolution (the number of main echogram values).

There are certain limitations on the block size of an Ethernet message. For further details, refer to the “Communication ports” section of the manual.

For descriptions of the rest of the commands, refer to paragraph 3.1.

11 SERIAL COMMUNICATION MENU

```
SERIAL COM. MENU

Telegram Menu
USART Menu
Echogram-1 Menu
Echogram-2 Menu
Echogram-3 Menu
```

This menu contains submenus used to access and adjust the various Serial Communication functions. Refer to the “Serial communication ports” chapter in the “Communication ports” section of the manual for further details.

11.1 SERIAL/TELEGRAM MENU

```
SERIAL/Telegram Menu

Format                  ASCII
Modem Control             Off
Remote Control             On
Status                    Off
Parameter                 Off
Annotation                Off
Navigation                Off
Sound Velocity            Off
Motion Sensor             Off
Depth                     Off
Depth NMEA                Off
Echogram                  Off
Echo-Trace                Off
Sv                        Off
Vessel Log                Off
Layer                     Off
Integrator                Off
TS Distribution           Off
Towed Fish                Off
```

This menu contains the commands that control the composition of output data telegrams on the serial port. Refer to the "Serial communication ports" chapter in the "Communication ports" section of the manual for further details.

Except for the *Format* and the *Modem Control* commands, the commands are identical to those in the ETHERNET/Telegram Menu. For descriptions, refer to paragraph 10.1.

Format

Options:

ASCII
Binary

This command is used to select either the *ASCII* or the *Binary* format for the output telegrams. The formats are described in detail in the "Communication Ports" section of this manual.

Modem Control

Options:

Off
On

This command is used to enable modem data transfer. When *Modem Control* is *On*, a command string for enabling of "auto answer mode" is sent. This enables the echo sounder to be called remotely and for data to be transferred through the telephone network.

11.2 SERIAL/USART MENU

```
SERIAL/USART Menu

Baudrate                 9600
Bits Per Char.              8
Stop Bits                   1
Parity                   None
```

This menu is used to set up baudrate, bits per character, number of stop bits and parity for serial telegrams.

Baudrate

Options:

300	*4800*
600	*9600*
1200	*19200*
2400	

This command sets the baudrate, in bits per second for the RS 232 port.

Bits per Char.

Options:

7
8

This command sets the number of bits used to transmit each character (RS232 port).

Stop Bits

Options:

1
2

This command sets the number of stop bits used when transmitting a character (RS232 port).

Parity

Options:

None
Odd
Even

This command sets the type of parity used (RS 232 port).

11.3 SERIAL/ECHOGRAM-# MENU

```
 SERIAL/Echogram-# Menu

Range                  100 m
Range Start              0 m
Auto Range             Off
Bottom Range            15 m
Bot. Range Start        10 m
No. of Main Val.       250
No. of Bot. Val.        75
TVG                20 log R
```

= Transceiver number.

This menu is used to enter echogram settings for echograms to be transmitted via the serial port.

For descriptions of the *Range, Range Start, Auto Range, Bottom Range, Bot. Range Start* and *TVG* commands, refer to paragraph 3.1.

For description of the *No. of Main Val.* and *No. of Bot. Val.* commands refer to paragraph 10.3.

12 ANNOTATION MENU

```
          ANNOTATION MENU

Event Counter                0
Counter Mode          Increase
Time Interval            0 min
Baudrate                  9600
Bits per Char.               8
Stop Bits                    1
Parity                    None
```

The Annotation Menu contains the commands enabling you to adjust the event count numbers, choosing the time between date/time annotations and setup parameters for the serial port.

The commands *Baudrate*, *Bits per Char.*, *Stop Bits* and *Parity* are the same as for the SERIAL/USART Menu. For descriptions, refer to paragraph 11.2.

Event Counter

Options:

0 to 10,000 in steps of 1.

This command generates an event number. If you enter an "event count number", an "event" with the selected number is generated. Events can thereby be generated via the menu just by entering the current event counter value. Events may also be generated from an external push button, and the event count number will then be incremented by 1 for each push of the button.

An "event" results in an event marker on the echogram on both the display and the printer, if the event marker parameter in the display/printer menu is set to *On*. The current event number is also included on the printout.

Counter Mode

Options:

Increase
Decrease.

This command makes it possible to choose between increasing or decreasing the event number each time an event is generated.

Time Interval

Options:

0 to 60 minutes in steps of 1 minute.

This command enables automatic generation of date/time annotations. Entering a value of n minutes will cause a date/time annotation to occur every nth minute. The value 0 disables this function.

For descriptions of the rest of the commands, refer to paragraph 11.2.

13 NAVIGATION MENU

```
        NAVIGATION MENU
Navig. Input               Off
Start Sequence          $GPGLL
Separation Char.          002C
Stop Character            000D
First Field No.              2
No. of Fields                4
Speed Input             Manual
Manual Speed          10.0 knt
NMEA Transfer              Off
Baudrate                  4800
Bits per Char.               8
Stop Bits                    1
Parity                    None
```

The Navigation Menu contains the commands to set up the system to decode the navigation and NMEA input telegrams.

The commands *Baudrate*, *Bits per Char.*, *Stop Bits* and *Parity* are the same as for the SERIAL/USART Menu. For descriptions, refer to paragraph 11.2.

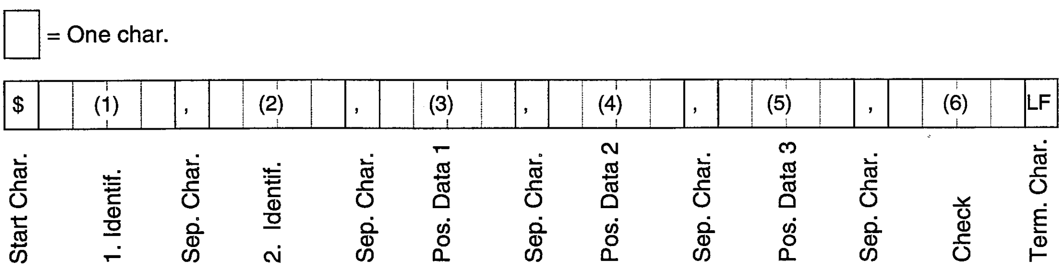
Decoding of navigation input telegrams is based on the recognition of a start sequence, a field separation character and a stop character. The “useful” sub-string within the total telegram is identified by specifying the position of the first field and the number of fields to be included in the navigation data sub-string. E.g. If the following NMEA 0183 telegram is received:

$GPGLL,4728.31,N,12254.25,W<CR><LF>

The “useful” navigation data sub-string becomes:

4728.31,N,12254.25,W

Example:



(CD431)

Note that <CR> denotes carriage return and <LF> denotes linefeed.

Up to six start characters may be defined in the start sequence. However, if there are no problems with ambiguity, some of the characters may be set to ? which indicates “don’t care” to test against equality.

The useful parts of the incoming navigation telegrams are displayed continuously while the Navigation Menu is selected. Also the speed extracted from the NMEA VTG speed input telegram is displayed.

Four parameters are provided for configuring the RS232 port.

The RS 232 port may be configured for different baudrates and communication protocols.

Refer to an appendix in this manual for table showing ASCII characters versus hexadecimal representation

Navig. Input

Options:

Off
Serial
Ethernet

This command enables you to select the source of the navigation input telegrams. The navigation input telegrams can come from either the serial input or the Ethernet input, or they can be switched off completely.

Start Sequence

Options:

0020h to 007Fh.

This command enables you to change the first characters in the telegram.
Up to 6 characters must be set in a sequence.
The ? sign indicates a don’t care character.

Separation Char

Options:

0000h to 007Fh.

This command sets the field separation character to be used. ("," corresponds to ASCII 2C hex)

Stop Character

Options:

0000h to 007Fh.

This command sets the stop character to be used. (<CR> corresponds to ASCII 0D hex)

First Field No.

Options:

1 to 100 in steps of 1.

This command identifies the field in which the first part of the position data will be located. *First Field No.* means the number of the character group which carries the first part of the actual position data. The position data will often be preceded by a number of system identification characters.

No. of Fields

Options:

1 to 100 in steps of 1.

This command sets the number of data fields to be used in the telegram. The *No. of Fields* means the total number of data groups used to give position data, including the 1st field.

Speed Input

Options

Manual
Serial
Ethernet

This command selects the source of the speed data input. Information on the vessel's speed can come from one of three sources; manual input, the serial line or the Ethernet line.

If *Manual* is selected, the vessel's speed must be set by the *Manual Speed* command.

Manual Speed

Options:

0.0 to 25.0 knots, in steps of 0.1 knot

This command enables you to select the vessel's speed, and is only effective when *Manual* is selected as *Speed Input.*

NMEA Transfer

Options:

Off
On

If *NMEA Transfer* is *On,* all NMEA telegrams received on the serial port will be output to the Ethernet port, and all NMEA telegrams received on the Ethernet port will be output to the serial port.

For descriptions of the rest of the commands, refer to paragraph 11.2.

14 SOUND VELOCITY MENU

```
     SOUND-VELOCITY MENU

Profile Type         Absolute
Depth Upper               0 m
Depth Lower            1000 m
Velocity Min.      1400 m/s
Velocity Max.      1600 m/s
Change profile      Set all
Load Profile       Nav.1.0m
Baudrate               9600
Bits Per Char.            8
Stop Bits                 1
Parity                 None
```

The echo sounder computes the bottom depth using a sound velocity profile. The sound velocity profile may be entered manually via the Sound Velocity Menu, or loaded automatically from a sound velocity probe or an external computer via Ethernet or serial communication ports. The Sound Velocity Menu contains the parameters associated with setting up the sound velocity profile.

For further details, refer to the "Sound velocity" chapter in the "Theory of operation" section of the manual.

The commands *Baudrate*, *Bits per Char.*, *Stop Bits* and *Parity* are the same as for the SERIAL/USART Menu. For descriptions, refer to paragraph 11.2.

Profile Type

Options:

Absolute
Mean

This command selects the display mode for the sound velocity profile. The sound velocity profile can be displayed in one of two ways: the *Absolute* velocity at each depth or the average *(Mean)* velocity from the surface and down to each depth can be shown. This command selects between the two.

Depth Upper

Options:

0 - 12,000 m in steps of 1 m.

This command sets the start depth of displayed sound velocity profile.

You need not have the entire sound velocity profile displayed. If you need to make accurate adjustments to a particular part of the profile, the appropriate part can be displayed by setting the limits in this and the *Depth lower* parameters.

Depth Lower

Options:

0 - 12,000 m in steps of 1 m.

This command sets the stop depth of displayed sound velocity profile.

You need not have the entire sound velocity profile displayed. If you need to make accurate adjustments to a particular part of the profile, the appropriate part can be displayed by setting the limits in this and the *Depth upper* parameters.

Velocity Min.

Options:

1400 to 1700 m/s in steps of 1 m/s.

This command sets the lower limit of the displayed sound velocity profile.

Velocity Max.

Options:

1400 to 1700 m/s in steps of 1 m/s.

This command sets the upper limit of the displayed sound velocity profile.

Change Profile

Options:

Set All
Edit

This command is used to change the depth and sound velocity values in the sound velocity profile. *Set All* sets all sound velocity values in the profile to a fixed value.

When *Edit* is selected, the current sound velocity profile may be altered. Altogether 100 pairs of depth and sound velocity values may be entered. The depth range is *0 m* to *12000 m*, and the sound velocity range is *1400 m/s* to *1700 m/s*.

Procedure:
1 - Select the *Pair Number* of the sound velocity value appearing in the menu at the bottom of the text section.

```
↑ = incr, max = 100
Pair Number              1
↓ = decr, min =    1

Depth                  1 m

Sound Velocity  1500.0 m/s
```

2 - Select/change the *Depth*

```
Pair Number              1

↑ = incr, max =  2
Depth                  1 m
↓ = decr, min =  0

Sound Velocity  1500.0 m/s
```

3 - Select/change the *Sound Velocity*

Pair Number	1
Depth	1 m
↑ = incr, max = 1700 **Sound Velocity 1500.0 m/s** ↓ = decr, min = 1400	

4 - Confirm new values by pressing the joystick to the right or leave values unchanged by pressing it to the left.

The sound velocity is now set for a certain depth and a pair of data is generated. If a change of a sound velocity value is wanted at other depths, repeat the procedure described above. The cursor will toggle between the depth setting and the sound velocity setting until the new sound velocity profile is entered (by pressing the joystick to the left).

Load Profile

Options:

Nav.1.0m
Nav.0.2m
Simrad-A
Simrad-B
AMLSVP16
AML-Calc

This command is used to load a complete sound velocity profile from an external device. The following options are available:

Nav. 1.0 m: This is for entering a profile on the RS-232 port from a Navitronic sound velocity meter with 1 meter depth resolution.

Nav. 0.2 m: Same as *Nav. 1.0* m, except that the sound velocity probe has a depth resolution of 0.2 meter.

Simrad-A: Loading Simrad ASCII sound velocity profile datagram (RS-232 or Ethernet). For further details, refer to the "Communication ports" section of this manual.

Simrad-B: Loading Simrad Binary sound velocity profile datagram (RS-232 or Ethernet). The datagram structure is found in the "Communication Ports" section of this manual.

AMLSVP16: Loading data directly from an Applied Microsystems Ltd. SVP-16 probe (RS-232).

AML-Calc: Loading Applied Microsystems Ltd. Calc file from a PC (RS-232).

After a successful transmission, the following message will be displayed:
Load finished, data ok.

Otherwise the following text will be displayed:
Load aborted, bad data

15 MOTION SENSOR MENU

```
        MOTION-SENSOR MENU

Heave                          Off
Roll                           Off
Pitch                          Off
Td-1 Ath. Offset             0.0 m
Td-1 Alo. Offset             0.0 m
Td-2 Ath. Offset             0.0 m
Td-2 Alo. Offset             0.0 m
Td-3 Ath. Offset             0.0 m
Td-3 Alo. Offset             0.0 m
```

This submenu enables you to select the source and format of the signal from the motion sensor device. Heave (meter), roll (degree) and pitch (degree) are continuously displayed at the bottom of the menu during pinging.

Heave

Options:

Off	
Ethernet	
+Linear	*+ 1 volt/m*
-Linear	*- 1 volt/m*

This command defines the *Heave* input signal. The heave input may be input as a numeric value via the Ethernet port or as an analog signal via the Auxiliary port.

Roll

Options:

Off	
Ethernet	
+Linear	*+1 volt/degree*
-Linear	*- 1 volt/degree*
+ArcSine	*Volt = 10 sin(angle)*
-ArcSine	*Volt = -10 sin(angle)*

This command defines the roll input signal. The roll may be input as a numeric value via the Ethernet port or as an analog signal via the Auxiliary port.

Roll information is handled in the computations as additional heave. Digital depth value will be corrected, but not the echogram itself.

Pitch

Options:

Off	
Ethernet	
+Linear	*+1 volt/degree*
-Linear	*- 1 volt/degree*
+Arcsine	*Volt = 10 sin(angle)*
-Arcsine	*Volt = -10 sin(angle)*

This command defines the *Pitch* input signal. The pitch input may be input as a numeric value via the Ethernet port or as an analog signal via the Auxiliary port.

Pitch information is handled in the computations as additional heave. The digital depth value will be corrected, but not the echogram itself.

Td-# Ath. Offset

Options

-99.9 to +99.9 m

This command enables you to set the athwartships distance between transducer and vertical reference unit. The value must be positive when the transducer is to the starboard side of the vertical reference unit. This parameter is used in the pitch and roll compensation, and will affect the accuracy of the compensation calculation.

Td-# Alo. Offset

Options

-99.9 to +99.9 m

This command enables you to set the fore-and-aft distance between transducer and the vertical reference unit. The value must be positive when the transducer is ahead of the vertical reference unit. This parameter is used in the pitch and roll compensation, and will affect the accuracy of the compensation calculation.

16 UTILITY MENU

```
         UTILITY MENU
Beeper                    On
Status Messages           On
RD Display               Off
FIFO Output              Off
Date                yy.mm.dd
Time                hh.mm.ss
External Clock           Off
Password                   0
Default Setting           No
Language             English
```

The Utility Menu contains the miscellaneous commands and parameters that are not included in other menus.

Beeper

Options:

Off
On

This command switches the beeper on and off. The beeper outputs short sound signals if status messages and warnings are displayed, and longer tones if an alarm occurs.

Status Messages

Options:

Off
On

By this command you can instruct the echo sounder to display or not to display the error, warning and alarm messages.

RD Display

Options:

Off
1
2
3

This command enables a designated depth telegram to be sent to the Simrad RD display.

FIFO Output

Options:

```
     OFF
#:       P
#:     V
#:     VP
#:   W
#:   W P
#:   WV
#:   WVP
#: B
#: B   P
#: B V
#: B VP
#: BW
#: BW P
#: BWV
#: BWVP
```

# = 1/2/3
P = TS samples
V = S_v samples
W = power samples
B = phase samples

This command enables data telegrams on the FIFO interface. The start depth and stop depth are determined by the limits of the super layer (refer to details in paragraph FIFO port in section "Communication ports" in this manual).

Date

Year, month and day are entered as a triplet into the EK 500 internal clock (battery backup power).

Time

Hour, minute and second are entered as a triplet into the EK 500 internal clock (battery backup power).

External Clock

Options

Off
Serial
Ethernet

This command synchronizes the echo sounder with external clock via Ethernet or serial port.

Password

Options:

0 to 9999.

This command enables the echo sounder to be protected by a password. A password number in the range 0 to 9999 can be entered. The menu system will then be locked until the selected password is re-entered.

Default Setting

Options:

No
Yes

This command sets the default values onto all the system parameters when specifying *YES*.

Language

Options:

English
French
German
Norw.

This command selects the language in which the menu text is displayed.

17 TEST MENU

```
            TEST MENU

Analog Input
Pulse Input
Ethernet
Message
Transceiver
Version
Counter
Scope
Serial Port
Simrad
```

The Test Menu contains miscellaneous commands for checking the hardware and software in the echo sounder.

Analog Input. The voltage at each of the four analogue inputs (auxiliary connector) is displayed.

Pulse Input. A pulse count number for each of the four external pulse inputs (auxiliary connector) is displayed.

Ethernet. Self testing of the Ethernet interface is performed. Return values are:

- 0 all tests passed
- 1 82586 self test failed
- 2 82586 loopback test failed
- 3 ESI (82501 or 8023) loopback test failed
- 4 transceiver loopback test failed

Message When set to *On*, a test message is transmitted to the Ethernet port and the serial communication port.

Transceiver

This menu entry is primarily used for checking the receiver response. For every ping, the display shows:
- the amplitude of sample 511 (dBW)
- the fore-and-aft electrical phase of sample 511 (phase steps)
- the athwartships electrical phase of sample 511 (phase steps)
- the background noise level (dBW)

Data from all three transducer channels is shown.

Version

The version of the installed software is displayed for each of the CPUs.

Counter

Options:

CP counter
SP-1 counter
SP-2 counter
SP-3 counter

This menu entry is used to check the activity of the control processor and the signal processor(s). A large figure means that the processor in question is not working at full capacity. A zero means that the processor is 100 % employed.

Scope

Options:

Off
AMPL. 1
AMPL. 2
AMPL. 3
AMP&PH 1
AMP&PH 2
AMP&PH 3

This command causes an oscilloscope picture of samples to be displayed. This is useful for checking the echo detection.

Serial Port

Options:

1a (DB)
1b (P5)
2a (P1)
2b (P2)
3a (P3)
3b (P4)

This menu entry is used to check the activity on the serial lines. The following data is presented:

Bytes input
Last inbyte
Bytes output
Last outbyte
Error count

Simrad

For Simrad use only.

850-130682 / AA000 / 1-11

EA 500 Maintenance

This section of the manual describes the maintenance to be performed by the system operator.

Document revisions

Rev	Date	Written by	Checked by	Approved by
A	15.03.96	CL	OL	EF
B	21.10.01	RBr	ESB	GM
C				
D				

(The original signatures are recorded in the company's logistic database)

Table of contents

Document history

(The information on this page is for internal use)

Rev.A	First edition as a combined module for EA 500 and EK 500. Was section 5 of P2158E and P2170E.
Rev.B	Document transferred to QS, now only valid for EA 500. No changes to the text.

1 INTRODUCTION

This chapter describes the preventive maintenance to be performed by the system operator. For details about corrective maintenance, refer to the EA/EK/ES 500 Service Manual. For information about error messages, refer to appendix ”Status and error Messages”.

2 PREVENTIVE MAINTENANCE ACTIONS

The preventive maintenance is very limited. When required, clean the surfaces of the equipment with a soft, lint-free cloth and a mild detergent. Keep the fan filter of the sounder unit free from dust and moisture.

For information about preventive maintenance on the printer, refer to the printer instruction manual.

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TECHNICAL SPECIFICATIONS

P3561 / 850-160178 / 4A010

This section of the manual presents the technical specifications for the EK 500 echo sounder system.

Document revisions

Rev	Documentation department		Hardware/Software Design		Project/Product Management	
	Date	Sign	Date	Sign	Date	Sign
A	02.05.96	CL	29.05.96	HS	29.05.96	[illegible]

List of contents

Document history

(The information on this page is for Simrad's internal use)

References

Rev. A First edition as module. Was part of section 1 of P2170E.

1 ECHO SOUNDER UNIT

1.1 OPERATION

Range	1, 5, 10, 15, 25, 50, 100, 150, 250, 500, 1000, 1500, 2500, 5000, 10000 meters
Phasing	Automatic or manual 0 to 10000 meters 1-meter increments
Display and printers	1, 2 or 3 echograms simultaneously on each device Individual setting of range and phasing for each device 12 colours (3 dB per colour) Colour scale related to true volume backscattering strength and target strength Bottom expansion Scale lines Integrator line Layer lines Trawl lines Event marker
Pingrate	Adjustable
Bottom detector	Software multichannel tracking algorithm Adjustable min. and max. depth for bottom detection
Log interval	Based on external log pulses, internally simulated pulses, time or ping count Adjustable Interval common to all transceiver channels

Layers	1 to 10 active layers Super layer for special purposes Individual parameter setting for each layer Overlapping layers allowed Further subdivision into equidistant sublayers available (max. 50 sublayers per layer) Layer settings common to all transceiver channels
Integrator	Virtually unlimited dynamic range Independent integration within each layer and each transceiver channel Tables available on printers and interfaces for each log interval Integrator deflection line available on display and printer for super layer
Single echo detection	Adjustable detection criteria parameters (echo length, phase jitter etc.) TS correction based on generalized transducer pattern model with adjustable parameters derived during calibration
Size distribution	24 TS classes (1.5 dB per class) Independent computation within each layer and each transceiver channel Tables available on printers for each log interval TS bar chart available on display for super layer

Fish behaviour	Horizontal projection window available on display for super layer All single echo detections within layer displayed Echo trace data for biggest fish inside super layer Allows visual observation of fish behaviour Simplifies positioning of reference target during calibration
Sound velocity	Programmable sound velocity probe
Output data	Programmable composition of telegrams Raw sample data (Phase, Power, Sv, TS) Echogram data
Navigation data	Programmable decoding of navigation telegram (NMEA 0183 included)
Alarm conditions	Minimum depth alarm Maximum depth alarm Bottom lost alarm

1.2 TRANSMITTER/RECEIVER

Transmit power regulation	0 dB, -20 dB relative to full power (-3 dB, -23 dB jumper selectable)
Transmit power stability	0.1 dB over temperature range
Output protection	Open circuit/short circuit (limited protection on 12 kHz unit)
Terminal impedance	60 ohms
Receiver input range	Non-saturated instantaneous dynamic range -160 dBW to -4 dBW, ≈ 5Vrms (dBs relative to 1 W)
Receiver amplitude resolution	0.01 dB
Receiver amplitude accuracy	0.1 dB wide bandwidth 0.3 dB narrow bandwidth

1.3 TRANSDUCER TYPES AND TRANSCEIVER PARAMETERS

Transducer type	Freq. (kHz)	Beam type	Absorption coeff. (dB/km)	Pulse length (ms)			Bandwidth (kHz)		Transmit. power (kW)	2-way beam angle (dB)	Transd. gain (dB)	3 dB beam width (°)	Sample dist. (cm)
12-16	11.990	single	1	1.0	3.0	10.0	1.2	0.12	2	-14.0	18.5	16 ±2	40
E-12_60	11.990	"	1	1.0	3.0	10.0	1.2	0.12	0.05		11	55 ±11	40
18-11	17.986	"	3	0.7	2.0	7.0	1.8	0.18	2	-17.0	23.0	11 ±2	25
63BA	17.986	"	3	0.7	2.0	7.0	1.8	0.18	4	-14.5	16.3	14x14 ±2	25
27-26	27.027	"	6	0.5	1.5	5.0	2.7	0.27	2	-18.0	24.0	10x13 ±2	15
27-26/21-E	27.027 27.027	"	6	0.5	1.5	5.0	2.7	0.27	3 1.5	-18.0 -13.0	25.5 20.5	10x13±1/2 10x20±1/4	10
38-12x20F	37.878	"	10	0.3	1.0	3.0	3.8	0.38	1	-13.5	21±1.5	12x20±2	10
38-26/22-E	37.878	"	10	0.3	1.0	3.0	3.8	0.38	2.4 1	-17.0 -13.0	24.5 20.5	9x13±1/2 23x13±3/2	10
38-7	37.878	"	10	0.3	1.0	3.0	3.8	0.38	4	-20.5	28.0	7x7±1	10
49-26	49.020	"	14	0.3	1.0	3.0	4.9	0.49	2	-18.0	25.5±1	8x11 ±1/2	8
50-18P	49.020	"	14	0.3	1.0	3.0	4.9	0.49	0.5	-12.5	20±1	18x18±3	8
50-10x17	49.020	"	14	0.3	1.0	3.0	4.9	0.49	1	-15.5	23±1.5	10x17±2	8
70-24	70.422	"	20	0.2	0.6	2.0	7.0	0.7	0.8	-16.5	24	11X11±2	5
120-25	119.047	"	38	0.1	0.3	1.0	12.0	1.2	1	-17.5	25±1	10x10±2	3
120-35/25-E	119.047	"	38	0.1	0.3	1.0	12.0	1.2	2 2	-27 -17.5	35±1 25.5±1	3x3±0.3 9.5x9.5±1	3
200-7	200.000	"	53	0.06	0.2	0.6	20.0	2.0	1	-21.0	28.5	7 ±1	2
200-28E	200.000	"	53	0.06	0.2	0.6	20.0	2.0	1.5	-21.0	28.5	7 ±1	2
200-30G	200.000	"	53	0.06	0.2	0.6	20.0	2.0	0.1	-8.5 ±1	16.6±1	30±3	2
200-35E	200.000	"	53	0.06	0.2	0.6	20.0	2.0	2	-27.5	35	3±0.5	2
710-30	714.286	"	201	0.02	0.05	0.2	71.0	22.4	0.1	-23±1	30.5±1	5 ±0.8	1
710-36	714.286	"	201	0.02	0.05	0.2	71.0	22.4	0.1	-28.5	36±1.5	2.8±0.5	1
38/200	37.878 200.000	"	10 53	0.3 0.06	1.0 0.2	3.0 0.6	3.8 20.0	0.38 2.0	1 1	-15±1 -21±1	22.5±1 28.5±1	13x13±2 7x7±1	10 2
50/200	49.020 200.000	"	14 53	0.3 0.06	1.0 0.2	3.0 0.6	4.9 20.0	0.49 2.0	1 1	-17±1 -21±1	24±1 28.5±1	11x11±2 7x7±1	8 2
ES18	17.986	split	3	0.7	2.0	7.0	1.8	0.18	2	-17±1	25±1	11±2	25
ES38-12	37.878	split	10	0.3	1.0	3.0	3.8	0.38	1	-15.5 ±1	23±1	12±1	10
ES38-B/D	37.878	split	10	0.3	1.0	3.0	3.8	0.38	4	-20.5 ±1	28.0±1	7x7±1	10
ES38-5	37.878	split	10	0.3	1.0	3.0	3.8	0.38	4	-24.0	30.0	4.7	10
ES70-11	70.422	"	20	0.2	0.6	2.0	7.0	0.7	.8	-16.5 ±1	24±1	11±2	5
ES120-7	119.047	"	38	0.1	0.3	1.0	12.0	1.2	1	-20.6	26.5	7.1	3
ES120-4x10	119.047	"	38	0.1	0.3	1.0	12.0	1.2	1	-22.0 ±1	29.5±1	4.4x9 ±0.5/1	3
ES120-2.5x10	119.047	"	38	0.1	0.3	1.0	12.0	1.2	1	-23.5 ±1	31.5±1	2.5x9.5 ±0.5/1	3
ES120H	119.047	split TX	38	0.1	0.3	1.0	12.0	1.2	1	-23±1	31±1 25±1	10x2.5 10x10	3
120-2/50	119.047	side scan	38	0.1	0.3	1.0	12.0	1.2	1	-18±1	25.5±1	1.9x49	3

1.4 PERFORMANCE

Computed maximum range for typical operational conditions:						
transd. type	freq. (kHz)	power (kW)	A (m)	B (m)	C (m)	D (m)
12-16	12	4	-	950	5000	13000
67CA	12	4	-	740	6000	13000
63BA	18	4	-	990	4700	8100
18-11	18	4	-	950	5000	9000
38-7	38	2	-	1000	2500	3400
49-26	49	2	-	780	1700	2400
120-25	120	1	-	380	700	940
200-28	200	1	-	310	530	680
710-36	710	0.1	-	95	110	170
ES38B	38	2	640	1000	2500	3400
ES120	120	1	250	380	700	940

General assumptions:

- Sound absorption according to Francois & Garrison, JASA Dec. 1982 (temperature = 10 degree Celsius, salinity = 35 parts per thousand, depth = 250 meter, pH = 8)
- Total acoustic noise spectrum level is: 142 - 20 · log(f) dB rel 1 μPa per √Hz where f is the frequency in Hz (typical noise level for medium size vessel at 10 knots)

Range A (maximum range for automatic single fish detection)
TS = -30 dB (target strength
Medium pulse length and wide receiving bandwidth
SNR = 20 dB (signal-to-noise ratio)

Range B (maximum range for observation of a single fish on display or printer)
TS = -30 dB
Long pulse length and narrow receiving bandwidth
SNR = 10 dB

Range C (maximum range for automatic bottom detection)
S_S = -10 dB (surface backscattering strength
Medium pulse length and wide receiving bandwidth
SNR = 20 dB

Range D (maximum range for registration of bottom contour on display or printer)
S_S = -10 dB
Long pulse length and narrow receiving bandwidth
SNR = 10 dB

1.5 INTERFACES

Serial interfaces (9-pin Delta, RS232)	port 1: Remote computer command input and data output port 2: Annotation input from standard terminal port 3: Navigation data and NMEA input/NMEA data output port 4: Sound velocity probe input port 5: RD depth indicator output/trawl input
Parallel interfaces (25-pin Delta, Centronics)	Port 1: Colour printer 1 Port 2: Colour printer 2 Port 3: Colour printer 3 Port 4: Transducer multplexing
Auxiliary port (25-pin Delta)	Differential analogue input from heave sensor Transmit synchronization input/output Log pulse input (from vessel's log) Event marker input Alarm output
Remote control signals (25-pin Delta)	Separate lines: digits 0-9 cursor control
LAN port (15-pin Delta)	Ethernet type IEEE 802.3 UDP/IP communication protocol Command input and data output

RGB video (15-pin Delta)	Impedance 75 ohms 640 x 480 pixels resolution Line frequency 30 Hz Frame frequency 60 Hz noninterlaced Composite sync on green
Transducer signals (12-pin MIL type)	Single-beam signals Split-beam signals Cable screen
FIFO sample data signals (15-pin Delta)	Output sample data (Super layer)

1.6 TRANSCEIVER UNIT, GENERAL SPECIFICATIONS

Supply voltage	187 - 264 VAC 50/60 Hz 90 - 132 VAC 50/60 Hz (with transform-er) 22.5 - 31 VDC (with DC/AC converter)
Power consumption	100 W (one channel) 125 W (two channels) 150 W (three channels)
Operating temperature	0 - 55°C
Dimensions	W480 x H310x D440 (mm) (standard 19" rack dimensions)
Weight	25 kg (one channel) 30 kg (two channels) 35 kg (three channels)

2 DISPLAY AND KEYPAD UNITS

CF 140 14" COLOUR DISPLAY WITH BUILT-IN JOYSTICK	
Supply voltage	198 -264 VAC 50/60 Hz 90 - 132 VAC 50/60 Hz
Power consumption	90 W
Operating temperature	0 - 40°C
Dimensions	W410 x H360 x D460 (mm)
Weight	25 kg

CF 190 20" COLOUR DISPLAY WITH BUILT-IN JOYSTICK	
Supply voltage	198 -264 VAC 50/60 Hz 90 - 132 VAC 50/60 Hz
Power consumption	105 W
Operating temperature	0 - 40°C
Dimensions	W498 x H449 x D534 (mm)
Weight	29 kg

RD 110 11" LCD MONOCHROME DISPLAY WITH KEY FUNCTION	
Resolution	640 x 480 pixels
Supply voltage	+5V, ±15V DC (supplied from Sounder Unit)
Operating temperature	10 - 40°C
Dimensions	W380 x H250 x D75 (mm)
Weight	6 kg

RD DISPLAY	
Resolution	5 digits including 1 decimal
Supply voltage	187 - 264 VAC 50/60 Hz 90 - 132 VAC 50/60 Hz
Operating temperature	0 - 55°C
Dimensions	W260 x H158 x D127 (mm)
Weight	2 kg

KEYPAD FOR CURSOR CONTROL	
Dimensions	W50 x H25 x D100 (mm)
Weight	0.1 kg

3 PRINTER

	PaintJet	DeskJet, type 850C
Paper width	210 mm	210mm
Resolution	720 pixels across paper	720 pixels across paper
Supply voltage	187 - 264 VAC 50/60 Hz 90 - 132 VAC 50/60 Hz 21 - 31 VDC	100-240 VAC 50/60 Hz
Power consumption	20 W max.	48 W max.
Operating temperature	0 - 55°C	5 - 40°C
Dimensions	W442 x H98 x D302 (mm)	W444 x H226 x D396 (mm)
Weight	5 kg	6.5 kg

COMMUNICATION PORTS

P3562 / 859-160179 / 4AA010

This section of the manual describes in detail the serial communication port (port 1) and the Ethernet port used by the system. Examples are given of the telegrams handled by those ports. For information about the other ports, refer to section "System familiarization".

Document revisions

Rev	Documentation department		Hardware/Software Design		Project/Product Management	
	Date	Sign	Date	Sign	Date	Sign
A	02.05.96	CL	29.05.96	HS	29.05.96	RB
B	14.05.97	CL	14.05.97	HS	14.05.97	RLN

List of contents

Document history

(The information on this page is for Simrad's internal use)

Revisions:

Rev. A First edition as module. Was section 4 of P2170E.
Rev. B Some minor corrections

1 SERIAL COMMUNICATION PORT

1.1 GENERAL

The serial communication port on the EK 500 (port 1) is of type RS232. Communication parameters such as baud rate, bits per character etc. can be programmed from the "Serial Communication Menu". The port may be connected to an external computer, a terminal, a printer, navigation equipment or any devices that can receive or transmit RS232 ASCII data.

The messages transmitted and received on the serial communication port are referred to as "telegrams".

The following information applies to all telegrams:

- All output telegrams contain a two-character header indicating the telegram type, for example PR for Parameter Request telegrams.

- "#" stands for the transceiver number 1/2/3 in output telegrams.

- "," separates fields within a telegram.

- <CR> denotes carriage return and <LF> denotes line feed.

- Two consecutive carriage returns <CR><CR> are used as telegram terminator in output telegrams implying that <CR><LF> can be used freely inside the telegrams in order to obtain a nice printout when using a standard printer.

- All output telegrams contain a time tag in the second field: hour, minute, second, hundredth of a second, for example 10024311.

- A menu parameter is identified by including its path in the menu system in the appropriate field.

  For example:

  /DISPLAY MENU/Echogram-1 Menu/TVG

  addresses the TVG type to be used for echogram 1 on the display.

The * character may be used as a wildcard in the parameter input telegrams.
The path string above would then look like:
/D*/*1*/TV*

- Input telegrams use a single carriage return <CR> as telegram terminator.

- The input telegram interpreter is insensitive to upper/lower case letters.

There are three types of output telegrams:

- Asynchronous telegrams (triggered by uncorrelated external or internal events)

- Ping-based telegrams

- Log-based telegrams.

There are five types of input telegrams:

- Parameter request telegrams

- Parameter enter telegrams

- Comment string (annotation) telegrams.

- Sound velocity telegram.

- External alarm telegram.

1.2 OUTPUT TELEGRAMS

Serial port output telegrams may be in either ASCII or binary format. The binary format is identical to the LAN (Ethernet) format (refer to paragraph 2) except for a header (4 bytes) containing the number of bytes in the telegram (2 bytes) and its checksum (2 bytes). The checksum is the arithmetic sum of all bytes in the telegram. This checksum is used by the receiving system to ensure good quality of data telegrams. Telegrams with a faulty cheksum should be disregarded.

The ASCII format should be selected when the need for reading the data as text is important. Binary is more compact, and is used for data transfer directly to computer or via modem.

1.2.1 Asynchronous output telegrams

Examples of asynchronous ASCII output telegrams:

```
PR,10024311,/OPERATION MENU/Ping Mode=Normal<CR><CR><LF>             → parameter request
PE,10024723,/OPERATION MENU/Ping Interval=1.3 sec<CR><CR><LF>          → parameter enter
CS,10031142,TS measurements near Greenland<CR><CR><LF>     → comment string (annotation)
GL,10031522,4728.31,N,12254.25,W<CR><CR><LF>                         → navigation data
ST,10041148,Ping-interval warning<CR><CR><LF>                        → status telegram
SV,10041150,002,00001,1500.0,00002,1500.0,<CR><CR><LF>       → sound velocity telegram
```

PR is returned as a response to a parameter request (input telegram) and contains the header PR, the time tag, the path and the parameter.

PE reports that a parameter has been entered (due to a manual command operation from the menu), and contains header, time tag, parameter.

CS reports that an annotation comment string has been entered (directly via serial port 2 or as an input annotation telegram), and contains header, time tag, annotation string.

GL contains navigation data: header, time tag, position data sub-string.

ST reports errors, warnings and alarms: header, time tag, message string.

SV sound velocity telegram contains current sound velocity profile: header, time tag, number of valid values, depth-1, sound velocity-1, depth-2, sound velocity-2 and so on.

1.2.2 Ping-based output telegrams

Examples of ping-based ASCII output telegrams:

```
D#,10024331,74.42,-18,  1,-23<CR><CR><LF>                         → sounder depth
MS,10024331,-1.23,  0.0,  0.0<CR><CR><LF>                         → motion sensor
E#,10024331, 5,<CR><LF>                                           → echo trace
   32.41,-41.6,-43.2, -2.3,  3.4,<CR><LF>
   36.32,-29.2,-31.1,  4.1, -4.3,<CR><LF>
   37.77,-33.7,-34.1,  2.2,  2.2,<CR><LF>
   42.11,-45.2,-45.9, -1.2, -1.5,<CR><LF>
   61.11,-37.7,-38.6, -3.3,  2.4,<CR><CR><LF>
S#,10024331, 3,<CR><LF>                                           → ping based Sv
   1,-87.5,  30.00,<CR><LF>
   2,-56.3,  28.72,<CR><LF>
   9,-61.6,  20.00<CR><CR><LF>
Q#,10024331,0,   74.42,     0.0,  100.0,250,   10.0   -5.0, 75,...<CR><CR><LF>
```

D1, **D2** and **D3** contain the detected depth: header, time tag, depth [meter], bottom surface backscattering strength [dB], transducer number, dummy.

MS contains the heave sensor reading: header, time tag, heave [meter], roll [degree], pitch [degree].

E1, **E2** and **E3** contain single-echo detections for one ping: header, time tag, number of single echo detections, depth [meter], compensated TS [dB], uncompensated TS [dB], fore-and-aft angle [degrees], athwartships angle [degrees] etc. Note that max. 30 single-echo detections can be output.

S1, **S2** and **S3** contain the mean S_v per ping inside each active main layer and the effective thickness of the layer: header, time tag, number of active layers, layer number, mean S_v [dB], effective thickness [meter] etc. Note that S_v values smaller than -99.9 dB causes $$$.$ to be printed.

Q1, **Q2** and **Q3** contain echogram data: header, time tag, TVG type, depth [meter], range start [meter], range end [meter], number of echogram values, bottom range start [meter], bottom range end [meter], no. of bottom echogram values, echogram data [dB].

The NMEA depth output telegram conforms to the standard NMEA-0183 DBS (Depth Below Surface) telegram format.

1.2.3 Log-based output telegrams

Examples of log-based output telegrams:

```
VL,10030741,960523,1834.015<CR><CR><LF>                     → vessel log
LL,10031124,960523,1835.000, 1, 3,<CR><LF>                  → layer settings
   1,S,  10.0,   40.0, 1.0, 3, -80.0,<CR><LF>
   2,S,  40.0,   70.0, 1.0, 4, -80.0,<CR><LF>
   9,B,  20.0,    0.0, 5.0, 2, -80.0<CR><CR><LF>
A#,10031124,960523,<CR><LF>                                 → integrator table
    31,   32,    72,<CR><LF>
   121,37E-2,15E-1,    11,<CR><LF>
  27E-1,   145<CR><CR><LF>
H#,10031124,960523,-50.0,<CR><LF>                           → TS distribution table
  818,38,38,17, 6, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,<CR><LF>
   73, 0, 0, 0, 0, 4, 4,11,16,14,10, 4,18,10, 3, 3, 3, 0, 1, 0, 0, 0, 0, 0, 0,<CR><LF>
   88, 0, 0, 0, 0, 3, 3, 9,16,11, 9, 5,18,12, 6, 2, 2, 1, 1, 0, 0, 0, 0, 0, 0<CR><CR><LF>
```

VL reports that a log pulse has been detected and contains header, time tag, date, updated log distance [nm].

LL is output every log interval and contains the current layer settings: header, time tag, date, current log distance [nm], super layer, number of active layers, layer number, layer type (S, B or P), upper depth [meter], lower depth [meter], margin distance [meter], number of sublayers, S_v threshold value [dB] etc.

A1, **A2** and **A3** are output every log interval and contain the integration results within each sublayer: header, time tag, date, sublayer 1 of first active main layer [m^2/nm^2], sublayer 2 of first active main layer [m^2/nm^2], sublayer 3 of first active main layer [m^2/nm^2], sublayer 1 of second active main layer [m^2/nm^2] etc. Note that a special exponential format is used for representing very small and very large numbers.

H1, **H2** and **H3** are output every log interval and contain the TS distribution within each layer: header, time tag, date, lower boundary of TS range [dB], total number of single echo detections within first active main layer, 24 fields containing detections within each TS class (percentage of relative total number of detections), total number of single echo detections within second active main layer etc.

1.3 INPUT TELEGRAMS

There are five different types of input telegrams:

```
/operation menu/ping mode<CR>                        → parameter request.
/operation/ping interval=1.3<CR>                     → parameter enter.
CS,Measurements near Greenland<CR>                   → comment string (annotation).
SV,10041150,002,00001,1500.0,00002,1500.0,<CR>       → Sound velocity telegram
                                                       (Simrad-A).
AL,#                                                 → External alarm, where if
                                                       # = 1: critical alarm, and if
                                                       # = 2: non-critical alarm.
```

A PR output telegram is returned by the echo sounder when a parameter request telegram is sent as input to the sounder (see paragraph 1.2.1). A parameter is entered by specifying path and new parameter value, separated by an "=" sign. It should be observed that:

- Continuous parameter values are processed numerically and may be entered with or without dimensions.
- Discrete (fixed) parameter values are processed as strings and must be entered with dimensions.
- The wild-card character * matches any sub-string of characters within menu names, parameter names and discrete parameter value strings.

- There is no distinction between upper and lower case characters.
- The password for the *Utility* menu and *Test* menu parameters cannot be remotely controlled or requested.

When SV is used, *Load Profile* in the Sound Velocity Menu must be set to *SIMRAD-A* (Simrad ASCII Sound Velocity Format).

Some parameters include two or more numerical quantities, and these are remotely entered/requested as shown below:

/eth*/loc*eth*=08:13:14:F3:98:10<CR>
/eth*/loc*ip*=131.051.171.087<CR>
/e*/r*eth*=10:11:AC:52:31:22<CR>
/e*/r*ip*=131.051.171.062<CR>
/utility*/date=90.01.24<CR> → year, month, day
/util*/time=14:41:16<CR> → hour, minute, second

The SIMRAD-B SV (Simrad Binary Sound Velocity) telegram has the following structure:

Description	Res.	Units	Format	Bytes #	Bytes Σ	Valid range	Note
Start character	-	Start of text (STX)	ASCII	1	1	02h	
Message type	-	-	binary	1	1	9Ah	
Date	1 1 1	DD-days MM-months YY-years	ASCII ASCII ASCII	2 2 2	6	1 - 31 1 - 12 0 - 99	
Time	1 1 1 0.01	HH-hours MM-minutes SS-seconds hh-seconds	ASCII ASCII ASCII ASCII	2 2 2 2	8	0 - 23 0 - 59 0 - 59 0 - 99	
No. of valid values	1	-	binary	2	2	1 - 100	1)
100 occurrences of: depth sound velocity	 1 0.1	 m m/s	 binary binary	 2 2	400	 0 - 12000 14000 - 17000	
End character	-	End of text (ETX)	ASCII	1	1	03h	
Checksum	- -	LSB MSB	binary binary	1 1	2	0 - 255 0 - 255	2)

Notes

1 The sound velocity profile datagram consists of 100 pairs of depth and corresponding sound velocity values. The “No. of valid values” determines the number of depth and sound velocity values which are valid in the table, starting from the first pair.

2 The checksum is calculated as for the output telegrams.

2 THE LAN PORT

2.1 GENERAL

Much of today's engineering effort is spent on system integration at various levels, and experience has shown that the integration costs frequently become comparable to the equipment cost. The EK 500 is prepared for system integration by incorporating a LAN (Local Area Network) interface of the Ethernet type. This interface provides efficient and high functionality interfacing to standard computers (DEC, SUN, HP, IBM PC etc.) used for remote control, data logging and postprocessing. Communication via the LAN port is based on the TCP/IP (Transport Control Protocol/Internet Protocol) protocol suite, a de facto standard which is included in the operating system kernel of virtually all UNIX computers and is available for most other common operating systems. The TCP/IP/ETHERNET standard is popular within office, engineering and university environments worldwide, and Simrad foresees that LANs of this type will become common on board research vessels in the near future.

The Ethernet standard is based on the CSMA/CD (Carrier Sense Multiple Access with Collision Detection) type of communication with 10 Mbit/s signalling rate over a 50-ohm coax cable. Equipment connected to the cable is individually addressed, and multiple computer-to-computer connections can coexist on the cable simultaneously by timesharing. Data terminal equipment (computers, EK 500 etc.) is connected to the Ethernet cable via a transceiver cable (15-pin Delta connector in each end) and a transceiver (a small unit with a "vampire" coupling mechanism for connection to the coax cable). Maximum extension of the Ethernet cable is 500 meters. The TCP/IP protocols are closely related to the ARPANET (Advanced Research Projects Agency NETwork) and to the UNIX operating system, and both connection-based and datagram-based communication are supported. The maximum average communication transfer rate of the EK 500 LAN interface has been measured to approximately 400 kbit/s which exceeds the continuously maintainable data storing speed of most computers (hard disk limitations). TCP/IP/ETHERNET equipment and parts are available from numerous suppliers, making system integration a “plumber's” task.

Specifically, communication with the EK 500 is based on UDP/IP/ETHERNET (User Datagram Protocol, member of the TCP/IP protocol suite) blocks, which include the following address fields:

• Destination ETHERNET address	(6 bytes)
• Destination IP address	(4 bytes)
• Destination UDP port number	(2 bytes)
• Source ETHERNET address	(6 bytes)
• Source IP address	(4 bytes)
• Source UDP port number	(2 bytes)

Thus, both the destination and source addresses are included in each data block, and a complete address comprises *Ethernet* address, *IP* address and *UDP* port number. Each device on the network must have a unique address. The Ethernet and IP address of the EK 500, henceforth called the local address, and the remote host, are entered from the Ethernet Communication Menu. The local UDP port number is hard coded to 2000 decimal and can not be altered. The destination UDP port number of output telegrams (remote UDP port number) can be individually set from the Ethernet Communication Menu for each telegram type, facilitating reception of different telegram types by separate tasks in a remote computer. There are three Ethernet address types: *Individual* (least significant bit of first byte is zero), *Multicast* (least significant bit of first byte is one), and *Broadcast* (all ones). Note that the EK 500's local Ethernet address must be an *Individual* address.

The LAN telegrams are binary equivalents to the ASCII telegrams on the Serial Communication port:

- Numeric quantities are represented by the appropriate binary type, and text strings remain unchanged.
- Output telegrams do not include carriage returns or line feeds.
- All output telegrams start with a two-character header and a time tag separated by a comma just as the ASCII version of the telegrams.
- Input telegrams on the LAN port and on the Serial Communication port are interpreted identically, implying that input telegrams must be terminated by a carriage return.

The telegrams are described in the next paragraphs using C programming language structures. The size of the various C types are:

• Char	8 bit integer.
• Short	16 bit integer.
• Long	32 bit integer.
• Float	32 bit floating point IEEE 754.

Structure members of the "Array" type are defined by their maximum size. During real data transfer, their actual size depends on EK 500 parameter settings and data statistics. Many computers can only access two-byte quantities at even addresses and four-byte quantities at addresses divisible by four. A few telegrams therefore include a dummy fill parameter to facilitate communication with these computers. Note that binary quantities are transmitted in "Intel byte order" (least significant byte first) and not in "network byte order" (most significant byte first). Thus, byte swapping at the remote host may be required.

2.2 ASYNCHRONOUS OUTPUT

```
struct Text {                  /* parameter request */
  char  Header[2];             /* "PR" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Text[256];             /* parameter path and value */
};

struct Text {                  /* parameter enter */
  char  Header[2];             /* "PE" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Text[256];             /* parameter path and value */
};

struct Text {                  /* comment string (annotation) */
  char  Header[2];             /* "CS" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Text[256];             /* comment string */
};

struct Text {                  /* geographical location (navigation) */
  char  Header[2];             /* "GL" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Text[256];             /* geographical position */
};
```

```
struct Text {                /* status telegram */
  char  Header[2];           /* "ST" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  char  Text[265];           /* error, warning or alarm message */
};
```

2.3 PING BASED OUTPUT

Binary values, except for the header.

```
struct Depth {               /* detected bottom depth */
  char  Header[2];           /* "D1", "D2", "D3" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  float Depth[4];            /* detected bottom depth [meter] */
  float Ss[4];               /* bottom surface backscattering strength [dB] */
  long Transducer Number[4];   /* transducer number */
  float AthwartShips;        /* athwartships bottom slope [deg] */
};

struct Motion {              /* motion sensor data */
  char  Header[2];           /* "MS" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  float Heave;               /* heave [meter] */
  float Roll;                /* roll [degree] */
  float Pitch;               /* pitch [degree] */
};

struct EchoTrace {           /* echotrace (single fish detections) */
  char  Header[2];           /* "E1", "E2", "E3" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  long  Traces;              /* number of echo traces in telegram */
  struct {
    float Depth;             /* target depth [meter] */
    float CompTS;            /* compensated TS [dB] */
    float UncompTS;          /* uncompensated TS [dB] */
    float AlongShip;         /* alongship angle [degree] */
    float AthwartShip;       /* athwartships angle [degree] */
  } Trace[30];               /* max 30 detections per ping */
};
```

```
struct MeanSv {               /* Mean Sv per ping */
  char  Header[2];            /* "S1", "S2", "S3" */
  char  Separator1[1];        /* "," */
  char  Time[8];              /* hour, minute, second, hundredth */
  char  Separator2[1];        /* "," */
  long  Layers;               /* number of active layers */
  struct {
    long  LayerID;            /* layer identifier [1-10] */
    float MeanSv;             /* mean Sv per ping within layer [dB] */
    float MeanWidth;          /* mean effective thickness of layer [meter] */
  } Layer[10];                /* max 10 layers */
};
```

```
struct Echogram {             /* echogram */
  char  Header[2];            /* "Q1", "Q2", "Q3" */
  char  Separator1[1];        /* "," */
  char  Time[8];              /* hour, minute, second, hundredth */
  char  Separator2[1];        /* "," */
  long  TVGType;              /* TVG type */
  float Depth;                /* detected bottom depth [meter] */
  float SurfaceUpper;         /* upper depth of surface echogram [meter] */
  float SurfaceLower;         /* lower depth of surface echogram [meter] */
  long  SurfaceCount;         /* number of surface echogram data points */
  float BottomUpper;          /* upper depth of bottom echogram [meter] */
  float BottomLower;          /* lower depth of bottom echogram [meter] */
  long  BottomCount;          /* number of bottom echogram data points */
  short Data[714];            /* max 714 pelagic+bottom echogram data points */
};
```

The Q# output telegram may be used by advanced postprocessing systems, and allows the results of an entire cruise to be replayed and recomputed off-line on a general purpose computer. Data elements corresponding to a maximum of 714 data points (pelagic echogram values + bottom echogram values) are transferred as one *UDP/IP/ETHERNET* block, every ping. The resolutions of the surface echogram and the bottom echogram are controlled by parameters in the Ethernet Communication Menu. The TVG type indicates which TVG function is used (0 = 20logR, 1 = 40logR, 2 = no TVG). Depth and range parameters are output in metres. The sizes of the surface echogram array and bottom echogram array are included. The S_S data is output in the EK 500 dB format (refer to paragraph 3 in the "Theory of operation" section).

```
struct Sample {              /* sample angle data */
  char  Header[2];           /* "B1", "B2", "B3" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  short Block;               /* sequence number of data block */
  short Offset;              /* offset within total data array */
  short Count;               /* number of bytes in this data block */
  short Data[727];           /* max 727 data points per data block */
};
```

The B# output telegram provides angle sample data from the transceiver (applies to split beam transducer channels only) and is used for special purpose studies. The fore-and-aft (alongship) and athwartships electrical angles are output as one 16-bit word; the alongship angle as the most significant byte and the athwartships angle as the least significant byte. Angle data is output in units of phase steps (64 phase steps = 180 electrical degrees) where the least significant seven bits are the magnitude and the most significant bit is the sign; zero in the fore and starboard direction, one in the aft and port direction. Thus, an angle is <u>not</u> expressed in 2's complement. Sample data is transmitted as one or more data blocks due to the fact that an Ethernet block only can contain data from 727 samples, and reassembly of the blocks at the reception site is based on the Block/Offset/Count parameters:

- <u>Block.</u> A sequence number is assigned to each data block. The first data block is assigned Block=0x0000, the second data block is assigned Block=0x0001, the third data block is assigned Block=0x0002 etc. Arriving at the final data block in the sequence the most significant bit of its block parameter is set to one. For example, with four data blocks in the sequence the last block will be assigned the number Block=0x8003.
- <u>Offset.</u> Each data block contains a fragment of the original total data array. The fragment offset (in bytes) relative the total array is included in each data block.
- <u>Count.</u> The fragment size (in bytes) of the data block.

```
struct Sample {              /* sample power data */
  char  Header[2];           /* "W1", "W2", "W3" */
  char  Separator1[1];       /* "," */
  char  Time[8];             /* hour, minute, second, hundredth */
  char  Separator2[1];       /* "," */
  short Block;               /* sequence number of data block */
  short Offset;              /* offset within total data array */
  short Count;               /* number of bytes in this data block */
  short Data[727];           /* max 727 data points per data block */
};
```

The W# output telegram provides echo amplitude sample data from the transceiver; power level referred to the transducer terminals as measured by the transceiver. Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

```
struct Sample {               /* sample Sv data */
  char  Header[2];            /* "V1", "V2", "V3" */
  char  Separator1[1];        /* "," */
  char  Time[8];              /* hour, minute, second, hundredth */
  char  Separator2[1];        /* "," */
  short Block;                /* sequence number of data block */
  short Offset;               /* offset within total data array */
  short Count;                /* number of bytes in this data block */
  short Data[727];            /* max 727 data points per data block */
};
```

The V# output telegram provides volume backscattering strength sample data; power sample data with 20-log-r TVG added (Refer to paragraph 2 in section "Theory of operation"). Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

```
struct Sample {               /* sample TS data */
  char  Header[2];            /* "P1", "P2", "P3" */
  char  Separator1[1];        /* "," */
  char  Time[8];              /* hour, minute, second, hundredth */
  char  Separator2[1];        /* "," */
  short Block;                /* sequence number of data block */
  short Offset;               /* offset within total data array */
  short Count;                /* number of bytes in this data block */
  short Data[727];            /* max 727 data points per data block */
};
```

The P# output telegram provides target strength sample data; power sample data with 40-log-r TVG added (Refer to paragraph 2 in section "Theory of operation"). Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

```
struct Sound Velocity {        /* sound velocity profile */
  char  Header[2];             /* "SV" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  short values;                /* number of values in telegram */
struct {
  short Depth;                 /* depth [meter] */
  short Velocity;              /* sound velocity [decimeter per second] */
} Profile [100];               /* max. 100 values */
};
```

2.4 LOG BASED OUTPUT

```
struct VesselLog {             /* vessel log */
  char  Header[2];             /* "VL" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Date[6];               /* year, month, day */
  char  Separator3[2];         /* ", " */
  float Distance;              /* vessel log distance [nautical mile] */
};
```

```
struct LayerSetting {          /* layer settings */
  char  Header[2];             /* "LL" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  char  Date[6];               /* year, month, day */
  char  Separator3[2];         /* ", " */
  float Distance;              /* vessel log distance [nautical mile] */
  short SuperLayer;            /* super layer identifier [1-10] */
  short Layers;                /* number of active layers */
  struct {
    short LayerID;             /* layer identifier [1-10] */
    short Type;                /* 'S' = surface, 'P' = pelagic, 'B' = bottom */
    float Upper;               /* upper layer boundary [meter] */
    float Lower;               /* lower layer boundary [meter] */
    float Margin;              /* margin distance [meter] */
    long  SubLayers;           /* number of sublayers within this layer */
    float Threshold;           /* Sv threshold value [dB] */
  } Layer[10];                 /* max 10 layers */
};
```

```
struct TableSA {                /* Integrator output table */
  char  Header[2];              /* "A1", "A2", "A3" */
  char  Separator1[1];          /* "," */
  char  Time[8];                /* hour, minute, second, hundredth */
  char  Separator2[1];          /* "," */
  char  Date[6];                /* year, month, day */
  char  Separator3[2];          /* ", " */
  float SA[363];                /* max 363 sublayers per Ethernet block */
};

struct TableTS {                /* TS distribution table */
  char  Header[2];              /* "H1", "H2", "H3" */
  char  Separator1[1];          /* "," */
  char  Time[8];                /* hour, minute, second, hundredth */
  char  Separator2[1];          /* "," */
  char  Date[6];                /* year, month, day */
  char  Separator3[2];          /* ", " */
  float MinTS;                  /* lower boundary of TS range [dB] */
  struct {
    long  Detections;           /* number of detections within layer */
    char  Class[24];            /* detections per TS class [%] */
  } Layer[10];                  /* max 10 layers */
};
```

2.5 ETHERNET PORT 10183 INPUT

The EK 500 is able to recognize NMEA-183 compatible vessel speed telegrams on UDP port number 10183:

```
$GPVTG,ddd,T,ddd,M,ss.s,N,,<CR><LF>
       |   | |   | |    |
       |   | |   | |    |__________ knot
       |   | |   | |_______________ speed
       |   | |   |_________________ magnetic
       |   | |_____________________ track deg.
       |   |_______________________ true
       |___________________________ track deg.
```

Please note that the EA 500 is only sensitive to the speed value in knots.

2.6 THE FIFO PORT

The FIFO port is an eight-bit parallel output interface for transferring sample data. The FIFO output might be connected to a standard Centronics interface on an IBM PC for collecting sample data.

The FIFO interface includes four telegrams:

- B# sample angle data
- W# sample power data
- V# sample S_v data
- P# sample TS data

Each FIFO telegram is divided into one or more 530-byte blocks than includes an 18-byte header and 512 bytes of sample data (256 samples). The number of samples are given by the limits of the super layer (max. 5000). The header carries the complete information needed for further processing of sample data.

After the FIFO Half Full signal is detected at the PC side, the data must be read within 50 milliseconds before the next block arrives. Note that all 530 bytes in the block must be read.

The telegram layout is identical to the corresponding Ethernet telegram except for the length of the sample data buffer. Program and cable needed for this interface can be supplied upon request from Simrad.

```
struct Sample {                /* sample angle data */
  char  Header[2];             /* "B1", "B2", "B3" */
  char  Separator1[1];         /* "," */
  char  Time[8];               /* hour, minute, second, hundredth */
  char  Separator2[1];         /* "," */
  short Block;                 /* sequence number of data block */
  short Offset;                /* offset within total data array */
  short Count;                 /* number of bytes in this data block */
  short Data[256];             /* max 256 data points per data block */
};
```

The B# output telegram provides angle sample data from the transceiver (applies to split beam transducer channels only) and is used for special purpose studies. The fore-and-aft (alongship) and athwartships electrical angles are output as two 8-bit words; the alongship angle as the most significant byte and the athwartships angle as the least significant byte. Angle data is output in units of phase steps (64 phase steps = 180 electrical degrees) where the least significant seven bits are the magnitude and the most significant bit is the sign; zero in the fore and starboard direction, one in the aft and port direction. Thus, an angle is <u>not</u> expressed in 2's complement. All samples (basic sampling rate of transceiver) inside the super layer are output. Sample data is transmitted as one or more data blocks due to the fact that a FIFO block only can contain data from 256 samples, and reassembly of the blocks at the reception site is based on the Block/Offset/Count parameters:

- <u>Block.</u> A sequence number is assigned to each data block. The first data block is assigned Block=0x0000, the second data block is assigned Block=0x0001, the third data block is assigned Block=0x0002 etc. Arriving at the final data block in the sequence the most significant bit of its block parameter is set to one. For example, with four data blocks in the sequence the last block will be assigned the number Block=0x8003.
- <u>Offset.</u> Each data block contains a fragment of the original total data

array. The fragment offset (in bytes) relative the total array is included in each data block.
- Count. The fragment size (in bytes) of the data block.

```
struct Sample {             /* sample power data */
  char  Header[2];          /* "W1", "W2", "W3" */
  char  Separator1[1];      /* "," */
  char  Time[8];            /* hour, minute, second, hundredth */
  char  Separator2[1];      /* "," */
  short Block;              /* sequence number of data block */
  short Offset;             /* offset within total data array */
  short Count;              /* number of bytes in this data block */
  short Data[256];          /* max 256 data points per data block */
};
```

The W# output telegram provides echo amplitude sample data from the transceiver; power level referred to the transducer terminals as measured by the transceiver. Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

```
struct Sample {             /* sample Sv data */
  char  Header[2];          /* "V1", "V2", "V3" */
  char  Separator1[1];      /* "," */
  char  Time[8];            /* hour, minute, second, hundredth */
  char  Separator2[1];      /* "," */
  short Block;              /* sequence number of data block */
  short Offset;             /* offset within total data array */
  short Count;              /* number of bytes in this data block */
  short Data[256];          /* max 256 data points per data block */
};
```

The V# output telegram provides volume backscattering strength sample data; power sample data with 20-log-r TVG added (Refer to paragraph 2 in section "Theory of operation"). Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

```
struct Sample {             /* sample TS data */
  char  Header[2];          /* "P1", "P2", "P3" */
  char  Separator1[1];      /* "," */
  char  Time[8];            /* hour, minute, second, hundredth */
  char  Separator2[1];      /* "," */
  short Block;              /* sequence number of data block */
  short Offset;             /* offset within total data array */
  short Count;              /* number of bytes in this data block */
  short Data[256];          /* max 256 data points per data block */
};
```

The P# output telegram provides target strength sample data; power sample data with 40-log-r TVG added (Refer to paragraph 2 in section "Theory of operation"). Data is output in the EK 500 dB format (Refer to paragraph 3 in section "Theory of operation"). See the sample angle telegram for general comments and a description of the fragmentation mechanism.

THEORY OF OPERATION

P3563 / 850-160180 / 4AA010

This section of the manual explains the theory and mathematical principles behind the EK 500 echo sounder operation.

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Rev. A First edition under this "P" number. Was section 3 of P2170E.

1 INTRODUCTION

1.1 GENERAL DESCRIPTION

In its maximum configuration the EK 500 scientific echo sounder includes three parallel transceiver channels. These three channels contain dedicated hardware, and they are to a large extent functionally independent.

Each channel performs bottom detection, echogram generation and echo integration, and for split-beam channels also target strength statistics are estimated.

During transmission the transducer is excited with a high power short duration pulse, and simultaneous excitation occurs for all active transceiver channels.

Output data is presented on a display and on printers with individual adjustment of echogram range and output format for each of the devices.

Each transceiver channel functionally consists of

* Transducer
* Transmitter/receiver and digitizing circuitry
* Signal processing subsystem

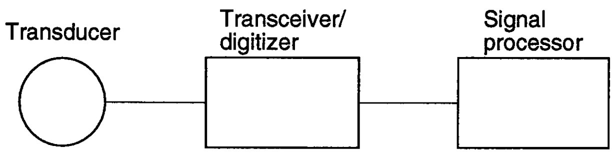

Figure 1 Transducer channel.

1.2 THE TRANSDUCER

The transducers are typically of two types:

CERAMIC The ceramic type is relatively lightweight and characterized by an efficiency of approximately 70%.

NICKEL The nickel type is heavier with an efficiency of approximately 25%.

The 3-dB beamwidth of commonly used transducers is in the range 2 to 20 degrees.

The transducer to transceiver/digitizer interface is based on a 60-ohm terminal impedance.

A two-wire connection plus screen are used for the single-beam transducers whereas the split-beam transducers require four two-wire connections plus screens.

1.3 THE TRANSCEIVER/DIGITIZER

The transceiver/digitizer combination contains transmitter, receiver and A/D-conversion circuitry.

The receiver does <u>not</u> contain any TVG (Time Varying Gain) function as the EK 500 implements this function solely in software. Instead, the receiving system is designed as a "power meter" with a large instantaneous dynamic range. Input power levels from -160 dBW to 0 dBW (dB's relative 1 W) are measured to a precision of a fraction of a dB and are output to the signal processor as 16-bit digital words using the dBW scale for numeric representation.

The receiver includes one receiving channel for single-beam operation and four matched channels plus phase measurement circuitry for split-beam operation.

1.4 THE SIGNAL PROCESSORS

The signal processor is based on the Intel 80286 microprocessor and the 80287 mathematics coprocessor. It is responsible for control of the transmitter/-receiver and for processing of received data. The signal processor generates individual echograms for each output device and estimates physical parameters (depth, volume backscattering strength, target strength etc) from the received signal samples by taking into account instrumental effects, transmission losses and transmitted power.

2 POWER BUDGET

The EK 500 utilizes a sophisticated receiver design which is characterized by a very high amplitude measurement accuracy over the entire dynamic input range (-160 dBW to 0 dBW). The absolute power level of the received signal is measured enabling the EK 500 to estimate volume backscattering strength and target strength in the absolute sense. The estimation algorithm is based on a physical model which accurately accounts for instrumental effects and propagation losses. This model will be outlined in order to assure that the measured output scattering parameters are correctly interpreted.

The radiation and receiving properties of a transducer is traditionally stated in terms of source level, directivity index, receiving response etc. However, the algorithms of the EK 500 uses the more modern concept of gain in order to facilitate power budget equations. The gain concept is used widely within many fields in physics and is accepted internationally as a convenient measure of the radiation properties.

Gain is defined as the intensity ratio observed at a distant point when using a real transducer and an idealized lossless omni-directional transducer keeping the electrical input power constant (see Figure 2).

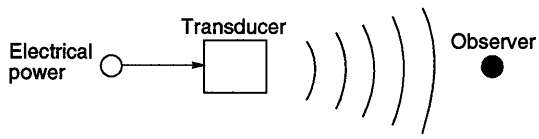

Figure 2 The gain concept.

Thus, gain accounts for both directional properties and losses and is independent of input power level, impedance and observation point. However, gain must be referred to a defined point on the terminal side of the transducer in order to uniquely identify the losses which are to be included. Gain (G) relates to directivity (D) as shown in equation 1:

$$G(\alpha,\beta)=\eta\cdot D(\alpha,\beta) \quad (1)$$

where α and ß are the directional angles, and η is the efficiency of the transducer. Thus, directivity is a normalized quantity which corresponds to the gain pattern of an identical but lossless transducer. Whereas gain is used for describing the radiation properties, it is common to state the receiving properties in terms of the effective receiving area (A).

Gain and effective receiving area are related by reciprocity as shown in equation 2:

$$A=\frac{\lambda^2}{4\pi}G \quad (2)$$

where λ is the wavelength and where A and G are both referred to the same point on the terminal side of the transducer. Figure 3 shows the gain pattern of a typical transducer.

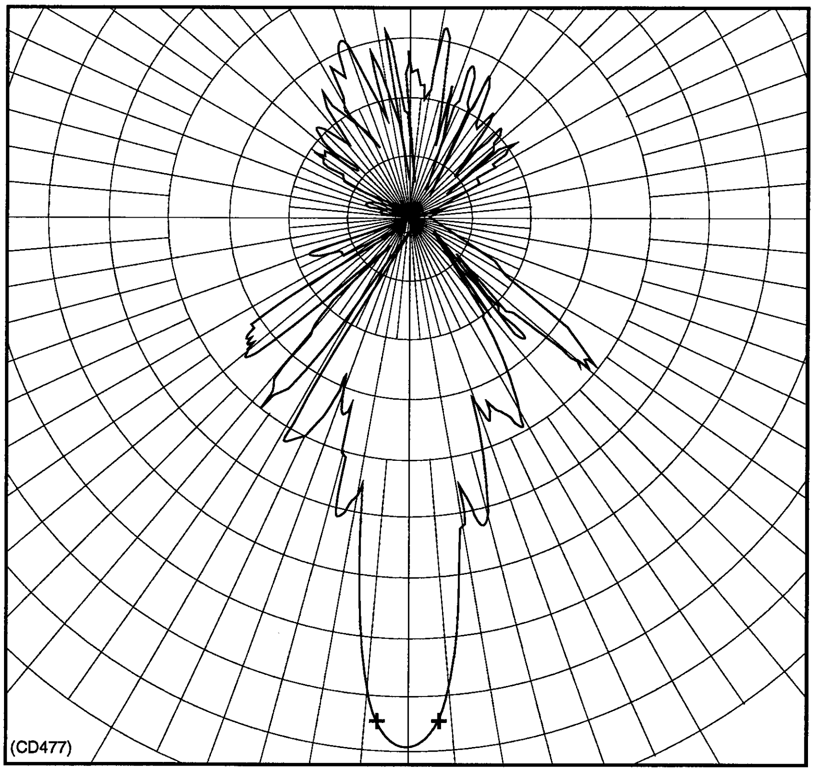

Figure 3 Beam pattern.

The echo from a small object, henceforth the target, is described by equation (3):

$$P_r = P_t G \frac{10^{-\alpha r}}{4\pi r^2} \sigma \frac{10^{-\alpha r}}{4\pi r^2} \frac{\lambda^2}{4\pi} G \quad (3)$$

where

P_r and P_t	are the received and transmitted power referred to the transducer terminals.
G	is the transducer gain towards the target.
r	is the transducer target range.
α	is the attenuation constant.
σ	is the effective backscattering cross-section area of the target.
λ	is the wavelength.

This expression can be recognized as the classic radar equation, and its derivation will be recapitulated.

Assuming an idealized lossless isotropic transducer the transmitted power will propagate evenly in all directions, and the power density at the transducer-target range is explained in expression 4:

$$\frac{P_t}{4\pi r^2} \quad (4)$$

The real transducer amplifies the radiated signal by a factor G in the direction of the target, and attenuation occurs while propagating from the transducer to the target. Hence, the real power density at the target becomes:

$$P_t G \frac{10^{-\alpha r}}{4\pi r^2} \quad (5)$$

The ability of an object to backscatter energy is stated in terms of its effective backscattering cross section area, henceforth the backscattering area, which roughly corresponds to the physical cross section area as seen from the transducer. Introducing this concept in the derivation the real target can be replaced by an isotropic transmitter of power:

$$P_t G \frac{10^{-\alpha r}}{4\pi r^2} \sigma \quad (6)$$

While propagating back towards the transducer attenuation and spherical spreading occur once more, and the power density at the transducer becomes:

$$P_t G \frac{10^{-\alpha r}}{4\pi r^2} \sigma \frac{10^{-\alpha r}}{4\pi r^2} \quad (7)$$

Received power at the transducer terminals is obtained by multiplying this power density by the effective receiving area of the transducer, and the complete equation becomes:

$$P_r = P_t G \frac{10^{-\alpha r}}{4\pi r^2} \sigma \frac{10^{-\alpha r}}{4\pi r^2} \frac{\lambda^2}{4\pi} G \quad (8)$$

Rearranging the terms a simple expression is obtained for calculating the echo properties of the target (equation 9):

$$\sigma = \frac{P_r 64\pi^3}{P_t G^2 \lambda^2} r^4 10^{2\alpha r} \quad (9)$$

In hydroacoustics it is common to state the echo properties in terms of backscattering strength rather than backscattering area, and the equivalent expression for point backscattering strength becomes (equation 10):

$$S_p = \frac{\sigma}{4\pi r_0^2} = \frac{P_r 16\pi^2}{P_t G^2 r_0^2 \lambda^2} r^4 10^{2\alpha r} \quad (10)$$

where r_0 = 1 meter is the reference range for backscattering strength. Finally, the EK 500 implements a logarithmic version of this equation 11:

$$10lg(S_p) = 10lg(P_r) + 10lg(r^4 10^{2\alpha r}) - 10lg(\frac{P_t G^2 r_0^2 \lambda^2}{16\pi^2}) \quad (11)$$

The left-hand side of this equation is commonly referred to as the target strength or simply TS. Thus, target strength is obtained by adding a range dependent term (corresponds to 40-log-r TVG) and a constant (accounts for equipment parameters) to the received signal power (digital word from transceiver/digitizer).

It should be observed that many of the internal algorithms of the sounder are based on the quantity 10log(S_P); TS echogram generation, size distribution statistics etc.

Having established the basic power budget equation for point backscattering, the extension to volume backscattering is straightforward. Whereas scattering from a small object is characterized by its backscattering area, the scattering from a homogeneous volume is characterized by the backscattering area per unit of water volume, $\partial\sigma/\partial V$. The equation for received power becomes (equation 12):

$$P_r=\int_V P_t G\frac{10^{-\alpha r}}{4\pi r^2}\frac{\partial\sigma}{\partial V}\frac{10^{-\alpha r}}{4\pi r^2}\frac{\lambda^2}{4\pi}G\,dV \quad (12)$$

where $\partial\sigma/\partial V dV$ is the backscattering area is from the small volume dV and where integration includes all volume V contributing to the received signal at a particular instant.

With a pulsed transmitter the volume V corresponds to a sphere of thickness $c\tau/2$ where c is the propagation speed in water and τ is the transmit pulse duration. Thus, the three dimensional integration over V can be replaced by a two dimensional integration over all solid angles 4π ($dV = \frac{1}{2}c\tau r^2 d\Omega$), equation 13:

$$P_r=P_t\frac{10^{-\alpha r}}{4\pi r^2}\frac{\partial\sigma}{\partial V}\frac{10^{-\alpha r}}{4\pi r^2}\frac{\lambda^2}{4\pi}\frac{c\tau}{2}r^2\int_{4\pi}G^2 d\Omega \quad (13)$$

The equivalent two-way solid beam angle Ψ is a key transducer parameter and is defined (equation 14):

$$\int_{4\pi}G^2 d\Omega = G_0^2\psi \quad (14)$$

where G_0 is the peak gain. Introducing this definition, rearranging the terms and normalizing with respect to r_0 the expression for volume backscattering strength becomes (equation 15):

$$S_v=\frac{\partial\sigma/\partial v}{4\pi r_0^2}=\frac{P_r 32\pi^2}{P_t G_0^2 r_0^2\lambda^2 c\tau\psi}\;r^2 10^{2\alpha r} \quad (15)$$

Again, the EK 500 implements a logarithmic version of this equation (equation 16):

$$10\log(S_v)=10lg(P_r)+10lg(r^2 10^{2\alpha r})-10lg\left(\frac{P_t G_0^2 r_0^2\lambda^2 c\tau\psi}{32\pi^2}\right) \quad (16)$$

Thus, volume backscattering strength is obtained by adding a range dependent term (corresponds to 20-log-r TVG) and a constant to the received signal power. The quantity $10\log(S_v)$ is used by many of the internal algorithms of the sounder; S_v echogram generation, echo integration, bottom detection etc.

3 EK 500 DB FORMAT

Simple conversion between dB and linear scale is obtained in a computer by using 10 dB x log(2) = 3.0103 - - - dB as a reference value in the dB domain. The EK 500 algorithms use 16 bit words to represent dB quantities.

```
    A        B
XXXXXXXX XXXXXXXX
```

The eight most significant bits (A) correspond to the integer part relative 3.0103 - - - dB and the eight least significant bits (B) correspond to the fractional part. Thus, the least significant bit corresponds to an increase/decrease of 3.0103 - - - dB/256 ≈ 0.01 dB. Assuming as an example the linear decimal number 178.125 the value of A and B becomes

10 dB x log(178.125) = 22.507 - - - dB

```
                                        A        B
22.507···/3.0103··· = 7.4767··· = 00000111.01111010
```

Conversion to linear scale is based on the relation

$$10^{0.30103\text{ - - - }x\,A.B} = 2^{A.B} = 2^{A+0.B} = 2^{A} \times 2^{0.B}$$

Evidently, the upper byte A is simply the exponent in binary floating point format, and 2 to the power 0.B is the mantissa. Thus, the mantissa can be obtained by using B as the address in an antilog lookup table containing 256 elements, and a similar technique can be used for the inverse conversion from linear to dB scale.

4 BOTTOM DETECTION

The bottom detection algorithm is implemented solely in software, and separate algorithms are run for each transceiver channel.

The algorithm is designed with emphasis on reliability in the sense that erroneous depth detections are never output. Whenever uncertainty is associated with a detection the algorithm outputs zero depth to indicate that no reliable detection was obtained. The algorithm is designed to maintain bottom lock for a discontinuous jump in bottom depth, and special features have been included in order to avoid false bottom detection on schools of fish.

Operational experience has shown that the algorithm indeed is quite robust; erroneous bottom detections are virtually absent, a dense school of fish does not confuse the algorithm, rough bottom contours cause only a few dropouts to occur.

Basically the algorithm is implemented as a fourfold tracking algorithm. For each ping up to four candidate bottom returns are identified, and their association with previous bottom candidates is determined in order to perform individual tracking of several potential bottoms simultaneously. For example, bottom return number one could be from a large school of fish, return two from the true bottom, and return three could be the echo which has travelled twice up and down between the surface and the bottom. A quality score is computed for each of the active channels of the tracking algorithm, and the channel with the highest score is assumed to contain the true bottom echo. Reliable depth detections are distinguished from unreliable ones by requiring a certain minimum quality score; reliable detections are output and for unreliable detections zero depth is output. The computation of quality is based on echo pulse characteristics, ping-to-ping history, proximity to the surface etc. The operating range of the algorithm can be set from the menu system (min depth, max depth).

In conjunction with echo integration it is vital that the bottom return is not included in the integration process. After bottom detection, therefore, an algorithm is activated which decrements the detected depth in small steps until the received echo signal has vanished. Experience has shown that this last technique substantially improves echo integration near the bottom. However, it should be observed that for an inclined bottom the detected depth tends to be slightly shallower than the true depth along the transducer axis.

5 BOTTOM RANGE

Bottom range is available on the display and on the printers and allows the echogram relative to detected bottom to be shown with a resolution different from that of the main echogram. This feature is useful when studying soft sediment layers and bottom consistency. Waves propagating down into the bottom are strongly attenuated, and echoes from subbottom layers are soon below the dynamic range of the echogram colour scale. Hence, additional amplification (performed in software) brings these echoes into the visible range. Excess amplification is set from the menu system in dB's per meter below the detected bottom. A typical value would be 0.5 dB/m. However, the optimum value will depend on bottom type and frequency and should be found experimentally.

6 SOUND VELOCITY

Sound velocity in the sea varies with temperature, salinity and pressure, and a typical velocity profile is shown in Figure 4. Diurnal and seasonal variations occur in the upper 2 - 300 meters, and below 1000 meters the velocity profile is nearly constant. The EK 500 computes bottom depth by using a sound velocity profile rather than an average velocity for all depths. The velocity profile is entered manually from the EK 500 keypad, as remote control commands or as a combination of these methods. The following details should be observed:

- The default profile assumes a constant velocity of 1500 m/s for all depths down to 12000 meters.
- The sound velocity profile affects the computed bottom depth, echograms and the compensation for path loss (TVG).

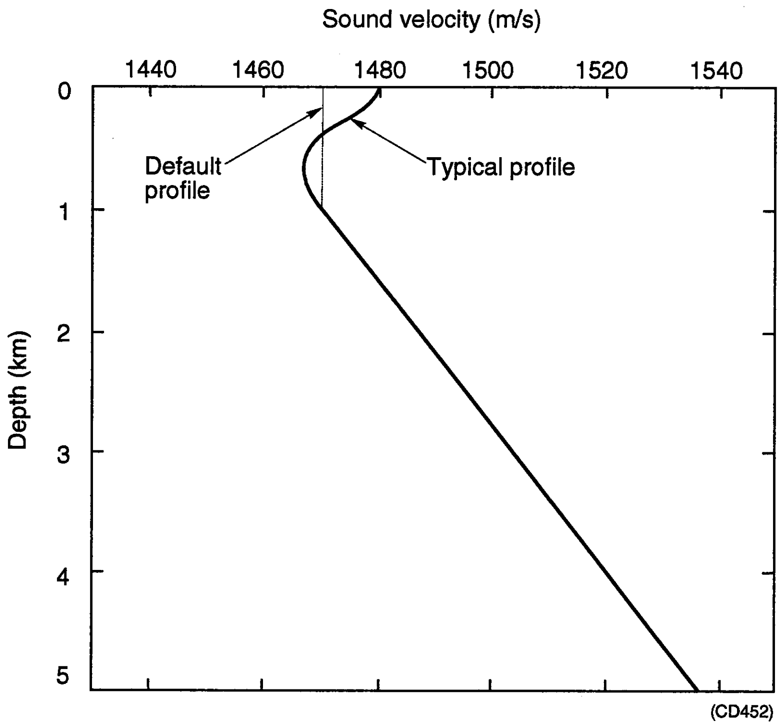

Figure 4 Typical velocity profile.

7 LAYERS AND AVERAGING INTERVAL

Much of the processing of the EK 500 is related to layers in the water volume. The layers are either referred to the sea surface or referred to the detected bottom, and only pings with a successful bottom detection are processed. For measurements in very deep waters a third layer type is provided; a pelagic layer is referred to the sea surface with processing of all pings whether bottom detection is successful or not. A maximum of ten layers can be defined, and overlapping layers are allowed. The processing within each transceiver channel is performed separately. However, the layers are common for all channels. The following parameters can be set from the menu system for each of the layers:

* The layer <u>type</u> is either off, surface locked, bottom locked or pelagic.

* The start depth (<u>range upper</u>) is referred to the sea surface for surface/pelagic layers and to the detected bottom for bottom layers.

* The <u>range</u> parameter is the thickness of the layer.

* The <u>margin</u> parameter causes a surface layer to stop at the margin distance above the detected bottom and a bottom layer to stop at the margin distance below the transducer face.

* The volume backscattering strength <u>(S_v) threshold</u> value for echo integration.

* Each layer can be divided into a number of equidistant <u>sublayers</u>. The default value is one sublayer and the maximum setting is 50 sublayers per layer.

The EK 500 performs independent echo integration and size distribution processing (applies to split-beam transceiver channels only) within each layer, and for special purpose studies a further subdivision of the layers into equidistant sublayers is possible. Size distribution and echo integration tables may be printed by the printers and output via the Ethernet or serial interfaces. However, for one of the layers, henceforth the <u>super layer</u>, also a graphical presentation on the display is available; a bar chart showing the size distribution and an inclined line showing the buildup of the integrator. The super layer status can be attached to any of the ten layers but only to one at a time, and the attachment occurs from the menu system. The output of sample data and scope plots is also controlled by the super layer settings. Only sample data inside the super layer is output in sample mode, and the start of a scope plot coincides with the start of the super layer.

The computation of statistical parameters (size distribution and echo integration) is based on averaging along the path travelled by the vessel. The averaging interval is often referred to as the log interval. The start and the stop of the averaging interval are common to all transceiver channels and all layers. The averaging interval is set from the menu system in units of nautical miles, and a typical interval would be 5 nautical miles. The nautical mile counter is normally controlled by electrical pulses from the vessel's log. However, the sounder can provide simulated log pulses in software when external pulses are not available.

8 ECHO INTEGRATION

The method of echo integration is recognized as an efficient and reliable technique for fish stock assessment. The EK 500 performs integration within independently set depth layers. Basically, the integrator performs integration in the vertical direction within the layers and averaging in the horizontal direction along the path travelled by the vessel. The integration process is based on the quantity $10\log(S_v)$ and is defined by the equations 17, 18 and 19:

$$\frac{\partial\sigma}{\partial V}=4\pi r_0^2\, S_V \qquad (17)$$

$$\frac{\partial\sigma}{\partial A}=\int_{r_1}^{r_2}\frac{\partial\sigma}{\partial V}dr \qquad (18)$$

$$\sigma_A = mean\,[\frac{\partial\sigma}{\partial A}] \qquad (19)$$

The first equation converts volume backscattering strength to backscattering area per unit of volume. The corresponding backscattering area per unit of horizontal area is obtained by integrating over the layer vertically, r_1 to r_2. The output parameter from the integrator each averaging interval σ_A represents the mean backscattering area per unit of horizontal area and is obtained by averaging the individual $\partial\sigma/\partial A$'s over one interval. The quantity s_A (m^2/nm^2) used by the Institute of Marine Research in Bergen, Norway is related to σ_A (m^2/m^2) as:

$$s_A = (1852\,m/nm)^2\sigma_A \qquad (20)$$

The algorithm implemented by the sounder is obtained by combining the four equations

$$s_A = 4\pi r_0^2 \cdot mean\ [\int_{r_1}^{r_2} S_V dr] \cdot (1852 m/nm)^2 \qquad (21)$$

Calibrating the sounder for the first time with a reference target a small discrepancy will most likely be observed between the measured S_A and the theoretically computed value (refer to appendix "Calibration of the EK 500"). This discrepancy is due to differences between the true and the nominal value of physical parameters; transducer gain, attenuation constant, transmit power etc. Agreement between the echo integrator output and the theoretically computed value is obtained by finetuning the peak transducer gain parameter (equation for volume backscattering strength in paragraph 3.2). This parameter is set from the menu system in units of dB. Note that different peak transducer gain parameters are used for computing target strength and volume backscattering strength.

To find mean S_v from s_A (equation 22):

$$S_V = \frac{s_A}{4\pi r_0^2 (1852 m/nm)^2 \cdot (r_2 - r_1)} \qquad (22)$$

9 SPLIT-BEAM OPERATION

Observation of fish with the EK 500 is based on echo integration for assessment of the total biomass and the split-beam technique for assessment of the size distribution of individuals. Thus, the split-beam feature represents a valuable supplement to echo integration.

A split-beam transducer is electrically divided into four quadrants as shown in Figure 5. All four quadrants are excited in parallel during transmission. However, the received signal from each quadrant is amplified separately in a four-channel matched receiver allowing the direction of arrival of an echo to be determined. An acoustic wavefront propagating towards the transducer arrives at different times at the four quadrants causing the phase angle of the electrical output signal from the quadrants to differ.

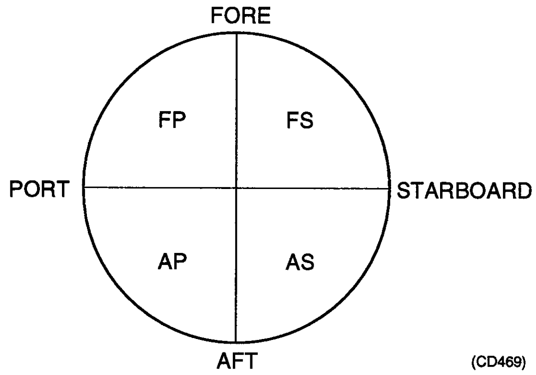

Figure 5 Split-beam transducer.

The fore-and-aft angle is determined from the electrical phase difference between the fore and the aft transducer halves (the FP+FS signal relative the AP+AS signal), and the athwartships angle from the starboard and port signals (the FS+AS signal relative to the FP+AP signal). The ratio between the electrical and mechanical angle is referred to as the "angle sensitivity" of the transducer.

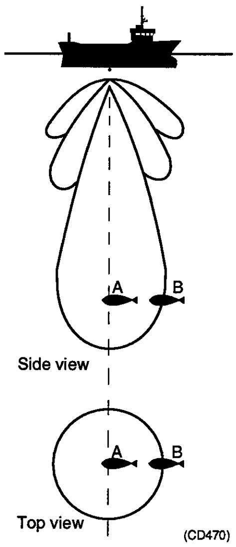

Figure 6 Split-beam principle.

In Figure 6 fish "A" is positioned along the transducer axis where maximum transducer gain occurs, and fish "B" is positioned towards the edge of the beam where the gain is lower. Evidently, the echo signal from fish "A" will be stronger than the signal from fish "B" even though they are of the same size and at the same depth.

Thus, determining fish size from received echo strength alone will not be successful. However, knowing the beam pattern of the transducer and the position of the fish within the beam it is possible to correct for the differences in transducer gain and thereby obtaining the true target strength of the fish.

The beam pattern correction in the EK 500 is based upon a model which is described in the appendix: Calibration.

The split-beam measurement principle only works for echoes originating from a single point target since the electrical phase will be random if echoes from multiple individuals at different positions in the beam are received simultaneously.

It is essential therefore to distinguish single fish echoes from multiple fish echoes, henceforth the single echo detection algorithm. The algorithm is based on a number of criteria, and some of these can be set from the menu system:

* TS must exceed the <u>min value</u> parameter (default -50 dB).

* The normalized echo length must exceed the <u>min echo length</u> parameter (default 0.8) where normalized echo length is the length between the 6 dB points relative the peak value divided by the duration of the transmitted pulse.

* The normalized echo length must be less than the <u>max echo length</u> parameter (default 1.8).

* The correction value returned by the gain correction model must not exceed the <u>max gain compensation</u> parameter (default 4 dB). Narrow beamwidth for small targets is obtained by using smaller max. gain compensation and should be considered when TS detection is poor.

* Average electrical phase jitter between samples inside an echo pulse must not exceed the <u>max phase deviation</u> parameter (default 2 phase steps) where max phase deviation is set in units of phase steps (64 phase steps = 180 electrical degrees). In a noisy environment or when the targets are small, the max. gain compensation and TS minimum values should be carefully optimized to suit the current situation.

10 IMPULSE RESPONSE

The transmitted signal is characterized by a square-like envelope with zero rise and decay times. However, on its way the signal passes through filters in the transmitter and receiver and twice through the transducer which has a bandpass-like response.

The shape of the received signal is therefore different from the transmitted one in the sense that the rise and decay times are no longer zero and the peak amplitude is slightly reduced as shown in Figure 7.

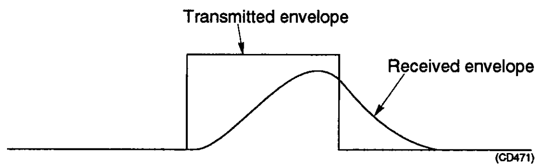

Figure 7 Signal envelopes.

The EK 500 corrects for these effects by

* including a small peak amplitude correction factor in the algorithm for point backscattering strength.

* using the effective pulse length rather than the transmitted pulse length in the algorithm for volume backscattering strength.

It should be observed that both absolute accuracy and, more important, consistency between TS and echo integration quantities are improved by including these corrections.

11 NOISE

The deep water performance of a sounder is determined by the system noise level; the sum of receiver noise, local noise and ambient noise.

Receiver noise includes thermic noise from the receiver itself and pickup noise from the digital circuitry of the sounder. The EK 500 utilizes a low noise receiver input stage, and the digital noise pickup has been reduced to an insignificant level by proper internal screening. Local noise includes propeller noise, engine noise, flow noise and other locally identifiable acoustic noise sources. Basically, this noise is related to vessel design and transducer installation and can be reduced significantly by taking the necessary precautions.

Ambient noise is the noise of the sea itself. It is that part of the total noise background of the sea which is not due to some locally identifiable source. The ambient noise level is subject to wide variations. Heavy shipping and strong wind increase the noise level, and in shallow water the noise level is typically higher than in deep water.

Noise can in most practical cases be considered "white" with a continuous power spectral density with respect to frequency. A quantitative evaluation of noise requires that the various contributions are all referred to a common point within the receiving system, and for most purposes it is convenient to use the transducer terminals as the common point. Referred to this point the total system noise is simply the sum of all individual noise power contributions.

However, the following equation defines their interrelation (equation 24):

$$P=SB=kTB=kT_0(F-1)B=NC\frac{\lambda^2}{4\pi}\eta B \qquad (24)$$

where:
P is the noise power inside the receiver bandwidth in watts.
B is the equivalent noise bandwidth of the receiver (normally somewhat larger than the 3 dB bandwidth).
$k = 1.38 \times 10^{-23}$ W/Hz/K is the Boltzmann constant.
$T_0 = 290°K$ is the standard reference temperature.
$C = 0.67 \times 10^{-18}$ W/Hz/m^2 is equivalent to 1 µPa/√Hz.
λ is the wavelength in water.
η is the efficiency of the transducer.

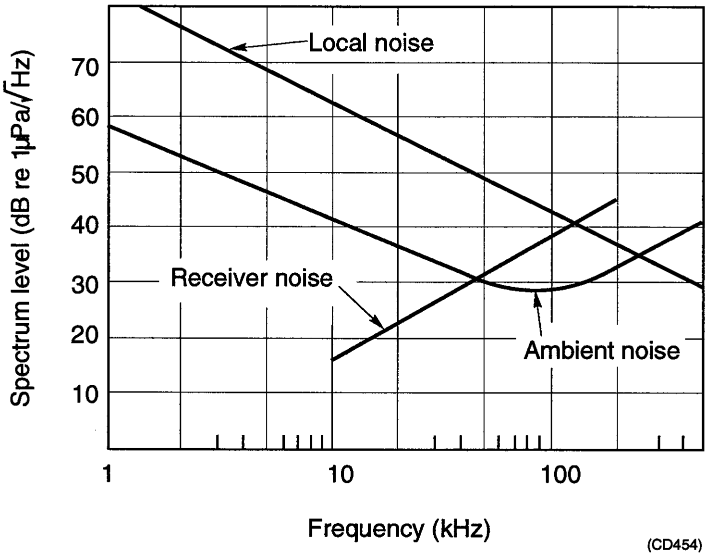

Figure 8 Receiver noise versus ambient noise.

Recalling that the nominal noise figure of the EK 500 is F ≈ 10 - 15 dB at all frequencies it is now a straightforward task to compute that this noise figure corresponds to a noise temperature of T = 2610°K and a single-sided noise power density of $S = 3.6 \times 10^{-20}$ W/Hz. Figure 8 shows receiver noise, local noise (medium size vessel at 10 knots) and average deep water ambient noise as a function of frequency.

The EK 500 provides a unique possibility for checking the noise level of the total installation, and a method of showing the maximum detection depth for a specified target strength. This is achieved by setting the min. TS in the echogram menu equal to a specified TS in passive mode, and the echogram range long enough to show when the noise begins to be displayed. The TS specified can be observed down to a depth just above the depth where the noise is displayed.

12 ABSORPTION COEFFICIENT

The absorption coefficient can be set in the Transceiver submenu. Figure 9 shows the variations of this coefficient for different frequencies and salinities.

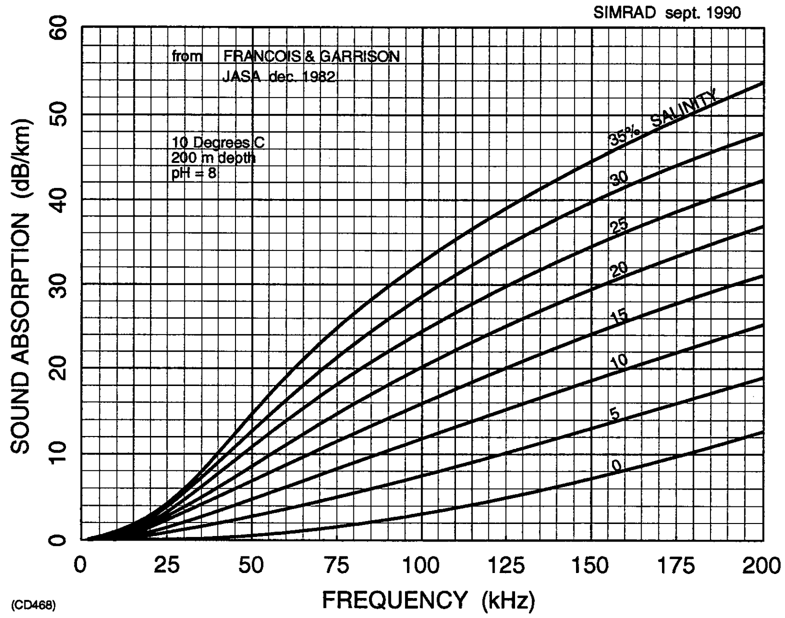

Figure 9 Sound absorption.

13 SYSTEM CONSIDERATIONS

Figure 10 shows a system implementation with three transceiver channels installed. In multichannel operation the EK 500 utilizes simultaneous transmission on all channels in order to avoid that transmission on one channel causes disturbances during reception on another channel. However, it should be observed that the receivers will experience a blanking interval subsequent to transmission due to the travel time of the direct transmit signal between the transducers. As a rule, therefore, the transducers should be installed at the same location on the vessel.

When connected to a heave sensor, compensation for heave is applied to echograms and measured depth. Different locations on the vessel will experience a different heave, and for correct compensation the heave sensor should be located near the transducers. Heave is sampled at the instant of transmission and at the instant of reception of the bottom echo, and the arithmetic mean is used in subsequent processing. Roll and pitch are sampled at the instant of reception only and are not averaged. The heave output telegram is time-tagged with the time of transmission of the ping.

The EK 500 performs no processing on navigation data. Input navigation data is time-tagged and simply included in the output data stream for use in subsequent postprocessing. Consequently, large variation can be tolerated in data format and position coordinate type; longitude-latitude, x-y coordinates, measured range to local repeaters etc.

The EK 500 is prepared for interfacing towards data logging and postprocessing systems of varying complexity. A simple system based on a standard PC would typically use the RS232 external computer port where commands for remote control and most of the output data types are available. However, the LAN port must be used for advanced applications where also sample data and echogram data are required. Sample data is used for special purpose studies, and echogram data allows a complete cruise to be replayed and recomputed off line on a graphics workstation; DEC, SUN, HP etc.

Communication via the LAN port is based on the TCP/IP protocol, the worldwide de facto standard, which is included in the operating system of virtually all UNIX computers and is available for most other common operating systems. The TCP/IP/ETHERNET standard is popular within office, engineering and university environments, and allows multiple computer-to-computer connections to coexist on the cable simultaneously by time sharing. Simrad foresees that LAN's of this type will be common on board research vessels in the future, and the EK 500 thus matches these systems neatly.

The EK 500 includes substantial processing power, and the capability is plentiful for normal operation and settings. However, some of the software algorithms can be very processing-intensive if unfavourable parameter settings are used. The following guidelines should be observed:

* A high noise margin (for example +10 dB) reduces processing time.

* The processing time for echogram generation and echo integration is roughly proportional to the total sum of all depth ranges; echogram range on display and printers, range or thickness of each layer. Thus, large overlapping layers are not favorable.
* Extensive use of the RS232 ports and LAN port can reduce the ping rate.

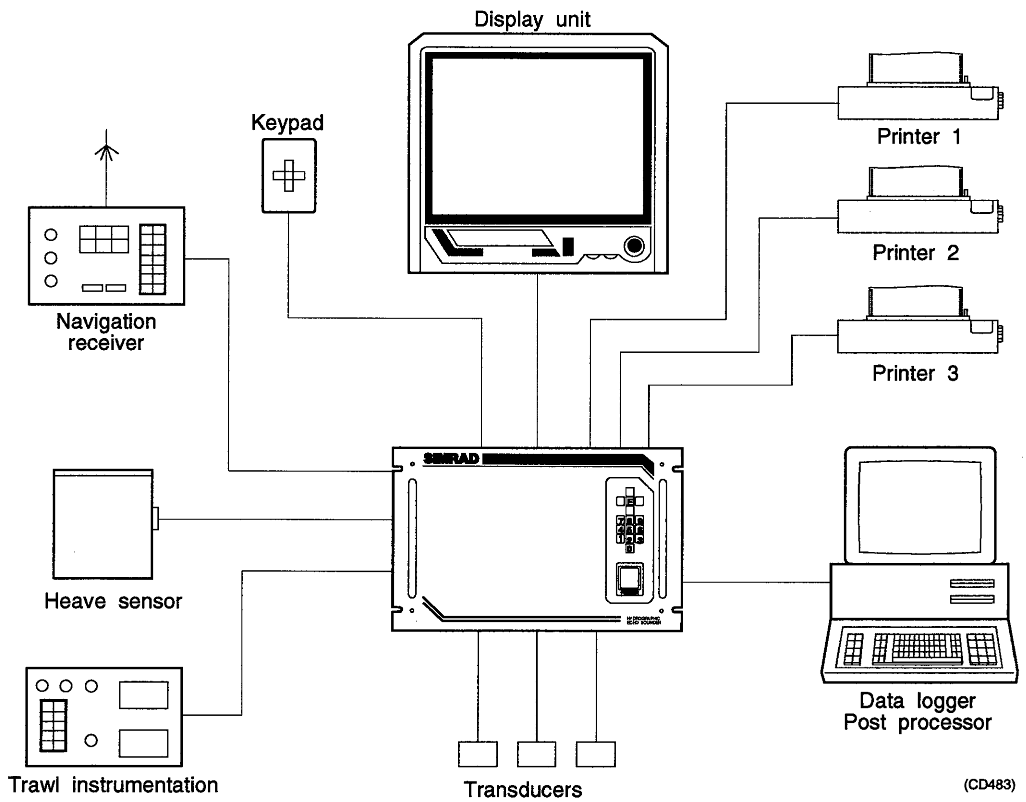

Figure 10 System implementation.

* Split-beam channels require more processing than single-beam channels.

* Above 120 Khz the average processing time per sample slightly exceeds the sampling time interval.

STATUS AND ERROR MESSAGES

P2265E / 859-043870 / 4AA005

This section of the manual details the status and error messages that may be displayed by the echo sounder from time to time. All the possible messages are listed, and an explanation is given for each.

Document revisions

Rev	Documentation department		Hardware/Software Design		Project/Product Management	
	Date	Sign	Date	Sign	Date	Sign
E	15.03.96	CL	18.03.96	OL	18.03.96	EF
F	22.05.97	CL	22.05.97	HS	22.05.97	RLN

List of contents

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(The remainder of the information on this page is for Simrad internal use).

Revisions:

Rev. A	01.02.91	Original edition.
Rev. B	25.06.92	Minor changes to text.
Rev. C	31.08.92	Document updated, minor changes to text.
Rev. D	16.06.93	Document re-formatted to bring it up to Simrad standards.
Rev. E		Document re-formatted to bring it up to new Simrad standards. This document now applies for both EA 500 and EK 500 echo sounders.
Rev. F		New error message included (Serial receive overload).

1 INTRODUCTION

The 500-series echo sounders may issue alarms, errors, warnings and other messages to the display and external devices (via serial port or Ethernet). Note that the # sign indicates the number of the transceiver unit affected (1/2/3). No number is issued for echo sounders with only one transceiver.

Note that the lists include messages for all the echo sounders in the 500 series.

2 GENERAL MESSAGES

All messages starting with "SP-#" concern signal processor no. # (described in chapter 3).

Message	Explanation
Bottom lost alarm #	Bottom tracking lost for transceiver-#
Display not ready	Display overload (may occur if system unable to update display with the current ping rate)
External trigger error	Expected trigger pulse not received
Illegal remote parameter	Parameter value of received remote command out of range or not recognized
Internal error #	*
Internal error 7	Spurious interrupt (caused by badly formed trigger pulses etc.)
LAN interrupt level fault	*
LAN invalid ind. address	The EA 500 local Ethernet address must be an individual address, i.e. least significant bit of first byte of address must be zero
LAN invalid multic. adr.	Invalid EA 500 multicast address
LAN multicast table full	*
LAN no command blocks	May appear while CPU is heavily loaded. Regular appearance of this message indicates a LAN interface terminator or hardware problem
LAN no transmit blocks	See above
LAN receive overload	Too much data received from LAN (Local Area Network), data is lost
LAN socket table full	*
LAN too high priority	*
LAN too long message	*

Message	Explanation
LAN UDP port busy	*
LAN 82586 init error	Unable to initialize 82586 chip. Possible hardware fault.
Maximum depth alarm #	Bottom of transceiver-# has been detected deeper than the maximum depth alarm setting
Minimum depth alarm #	Bottom of transceiver-# has been detected shallower than the minimum depth alarm setting
Navigation telegram error	Invalid navigation telegram received
Ping interval warning	Ping interval time exceeded
Printer-1 not ready	Printer-1 not connected, offline or not ready to print yet
Printer-2 not ready	Printer-2 not connected, offline or not ready to print yet
Printer-3 not ready	Printer-3 not connected, offline or not ready to print yet
Rem. annotation received	Remote annotation has been received successfully
Remote command ignored	Remote control received while remote control disabled
Remote parameter entered	Remote parameter received, decoded and entered successfully
Remote request executed	Remote request has been executed successfully
Serial Com. load warning	Too much data is directed to serial port, data may soon be lost
Serial Com. overload	Too much data is directed to serial port, data is lost
Serial line 1 error	Serial port 1 failure
Serial line 1B error	RD display serial port failure
Serial line 2 error	Serial port 2 failure
Serial line 3 error	Serial port 3 error
Serial line 4 error	Serial port 4 error
Serial receive overload	Unable to receive more data on serial port. Data is lost
Unknown error	*
Unknown remote command	Invalid remote command path/parameter received
Unknown transceiver type	Transceiver hardware switch not recognized
Display processor error	Display/graphic processor (80786) malfunction
Disk error 0	
File not found	
Replay end of file	
Replay data not found	
Replay bad data	
File create error	
File open error	
File write error	
File close error	

Message	Explanation
Disk full	
External critical alarm	External critical alarm received
External alarm	External alarm received

Table 1

* = Internal software problem encountered. If this error code is displayed, the incident should be reported to Simrad.

3 SIGNAL PROCESSOR (SP) ERROR MESSAGES

3.1 INTRODUCTION

The signal processor will read the control parameters sent by the control processor before initiating a new ping. The program will then test each parameter against its legal values. If the parameter is found to be illegal, or the value does not agree with the other settings, an error message code is sent to the control processor which will issue the error message.

At power-up the signal processors will never start real pinging until all the parameters are granted. However, in order to receive new information from the control processor, it will simulate pinging until no errors occur.

If the error message "SP-# not responding error" is shown on the display, the signal processor has not answered within a time-out period. This error is probably caused by one of the following hardware errors:

1 No signal processor PCB present.

2 A new PROM set is not properly inserted in the signal processor (check carefully).

3 The IC used for signalling is defective (U42 = 8255). This may be checked by inserting a new 8255.

4 The FIFO system on the digital interface pcb is not working properly. (If the sounder uses multiple frequencies, try exchanging the digital interface boards).

5 The signal processor is defective (replace the board, if possible).

3.2 LIST OF SIGNAL PROCESSOR ERROR MESSAGES

Note that the # sign indicates transceiver number (1/2/3) and that all error messages end with "error".

Error message	Legal values
SP-# angle sensi. error	0 to 100 el./mech.
SP-# bandwidth error	0 to 1
SP-# beamtype error	0 to 1
SP-# btm. min. level error	-80 to 0 dB
SP-# btm. max. depth error	0 to 20000 m
SP-# btm. min. depth error	0 to 1000 m
SP-# damping coeff. error	0 to 300 dB/km
SP-# device data error	See note I
SP-# equ. beam angle error	-100 to -1 dB
SP-# FIFO input error	0 to 1
SP-# frequency error	10^4 to 10^6 Hz
SP-# heave conver. error	-10 to 10 V/m
SP-# layer data error	See note III
SP-# noise margin error	0 to 40 dB
SP-# not responding error	See paragraph 3.1
SP-# ping mode error	0 to 3
SP-# pitch conver. error	-10 to 10 V/m
SP-# product type error	0 to 1
SP-# pulse length error	0.02 to 10 ms
SP-# roll conver. error	-10 to 10 V/m
SP-# sample interval error	0.005 to 0.5 m
SP-# sound velocity error	1400 to 1700 m/s
Sample tg error	0 to 1
FIFO tg error	0 to 1
SP-# transceiv. mode error	0 to 3
SP-# transceiver HW error	
SP-# transd. depth error	0 to 1000 m
SP-# transd. seq. error	
SP-# transd. param. error	See note II
SP-# transd. gain error	1 to 100 dB
SP-# transmit power error	0 to 10 kW
SP-# TS phasedevia. error	0 to 10
SP-# TS min. level error	-100 to 0 dB

Error message	Legal values
SP-# TS min. length error	0 to 10
SP-# TS max. length error	0 to 10
SP-# TS max. comp. error	0 to 6 dB

Table 2

<u>Note I</u>

SP-# device data error

The appropriate error message in Table 2 will be displayed if one or more of the following parameters are outside legal limits:

Parameter	Legal values
Bottom echogram dots	0 to 200.
Bottom range	0 to 100 m.
Bottom range start	-100 to 100 m.
Echogram dots	0 to 1000.
Range	0 to 10000 m.
Range start	0 to 10000 m.
Sub-bottom gain	0 to 5 dB/m.
TVG	0 to 2.

Table 3

Note II

SP-# transd. parameter error

The appropriate error message in Table 2 will be displayed if one or more of the following parameters are outside legal limits:

Parameter	Legal values
Alongship offset angle	-20° to 20° mechanical.
Athwartships offset angle	-20° to 20° mechanical.
Three dB bandwidth	0° to 50° mechanical.

Table 4

Note III

SP-# layer data error

The above error message will occur if one or more of the following parameters are outside legal limits:

Parameter	Legal values
Layer margin	0 to 10
Layer start	-100 to 20000
Layer stop	-100 to 20000
Layer type	0 to 3
No. of sublayers	1 to 50

Table 5

CALIBRATION OF THE EK 500 / EY 500

P2260 / 859-043867 / AA011

This document contains calibration procedures, procedures to determine the beam compensation in a split-beam system and procedures for noise measurements at sea.

Document revisions

Rev	Documentation department		Hardware/Software Design		Project/Product Management	
	Date	**Sign**	**Date**	**Sign**	**Date**	**Sign**
A	01.02.91	-				
B	31.08.92	-				
C	01.10.93	-				
D	28.05.96	CL	29.05.96	RLN	29.05.96	RB
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List of contents

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(The information on this page is for Simrad's internal use)

Revisions:

Rev. A Original issue
Rev. B Minor changes to the text.
Rev. C Minor changes to the text. EY 500 implemented.
Rev. D Various changes in the procedures. A chapter about the lobe calibration program is added. Ref. EM 10526.
Rev. E Some uneccessary information removed from pages 16-17, and a few minor corrections made on page 6, 8, 15 and on the Calibration Report sheet.

1 THE PURPOSE OF CALIBRATION

The EK 500 and EY 500 are scientific echo sounders designed for quantitative measurements, i.e. measurement of single fish target strength and measurement of biomass backscattering coefficient. During the calibration a reference target with a known target strength is lowered into the sound beam, and the measured target strength is compared with the known target strength. If it is necessary to adjust the echo sounder, this is performed by changing a parameter in the mathematical equations in software. Since the echo sounder is digital right from the receiver front end, there is no analog gain adjustment.

The reference target is normally a metal sphere. Simrad supplies copper spheres, one for each frequency. The sphere diameter is selected for minimum temperature dependence.

For acoustic surveys where accurate quantitative measurements are required it is essential that the echo sounder is correctly calibrated. It is a safe practice to perform the calibration before and after the survey. If experiences over time show that no adjustments are necessary, it may be appropriate to reconsider the need for frequent calibration. Simrad recommends that calibration is performed at least once a year, and in areas with different summer and winter condition at least twice a year.

In the following calibration procedure typical settings on the EK 500/EY 500 are specified:

Ping Interval:	*1 sec.*
Transmit Power:	*Normal (applies only for EK 500)*
Pulse Length:	*Medium*
Receiver Bandwidth:	*Wide*
Transducer Depth:	*0.0 m*

If other settings are to be used during the survey, the calibration should be repeated for these.

A lobe program which can be supplied from Simrad makes the TS gain calibration procedure a relatively uncomplicated task by using an extra PC connected to serial line 1 in a split-beam system. This program will be noncritical with respect to movement of the reference target sphere and it will enable the inexperienced operator to obtain a good calibration result. This program should be used whenever possible. This procedure is described in chapter 3.

2 CALIBRATION PROCEDURE

Check the hardware installation

Check that the transducer cable is connected to the correct transducer plug on the rear side of the EK 500 / EY 500.

Check the internal test oscillator

Select the Transceiver Menu and set *Mode* to *Test*.

Select the Operation Menu and set *Ping Mode* to *Normal* and *Noise Margin* to *0 dB*.

Select the Test Menu/Transceiver.

The amplitude of the internal test oscillator is now displayed. It should be -55 dB ±2 dB re 1W on a split-beam sounder and -61 dB ±2 dB re 1W on a single-beam sounder. If the amplitude is outside these limits, disconnect the transducer cable and check the amplitude to see if the fault is in the transducer or in the receiver. The amplitude should now be -49 dB ±2 dB re 1 W on a split beam sounder, and -55 dB ±2 dB re 1 W on a single beam sounder. If the amplitude is still outside the limits, the problem is probably related to the receiver. If it is inside the limits, the transducer impedance should be checked.

Rigging

The following rigging description is to a great extent reproduced from ICES report 144. The vessel should be anchored in calm and sheltered water. The depth must be sufficient for separation of sphere and bottom echoes. It is desirable, moreover, to work in water as deep as possible, consistent with maintaining a stable platform. Both bow and stern anchoring or tying are recommended. This is illustrated in figure 1.

Placing of winches

Winches should be used to guide and steer lines to the sphere for its centering in the echo sounder beam. Affix these winches to the deck railing in accordance with detailed ship drawings. Place the first winch in the transverse plane of the vessel running through the transducer. If the transducer is mounted on one side of the keel, place the first winch on the opposite side of the vessel. Place the second and third winches on the same vessel side as the transducer and at equal distances from the transverse section containing the transducer and first winch.

Each winch must be provided with a long spool of 0.60 mm diameter mono-filament nylon line, which is marked with small swivels at 5 m intervals, beginning 10 m from the loose end.

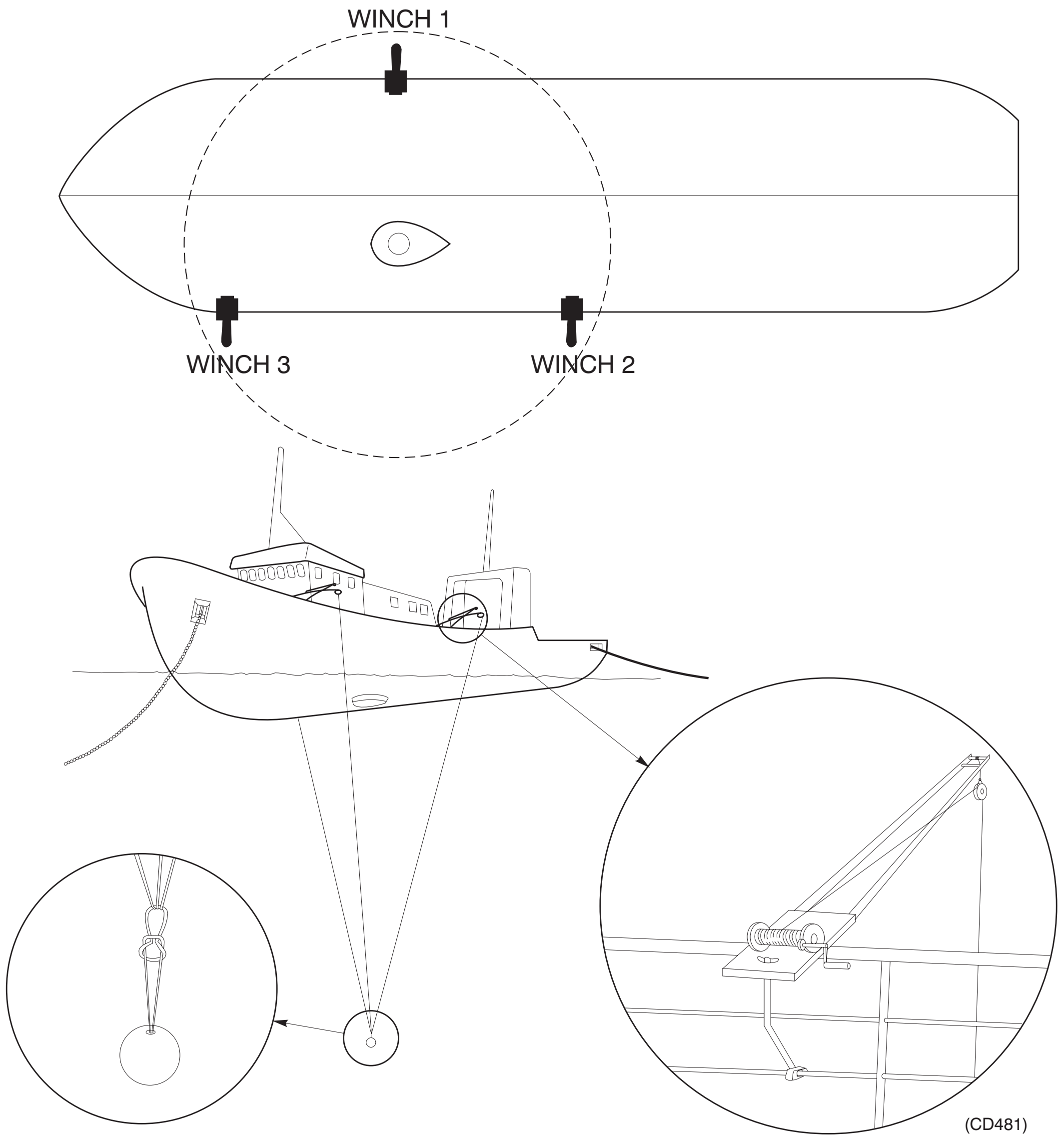


Figure 1 Rigging of a vessel for sphere calibration.

The purpose of the swivels is threefold:
- to unravel rotation of the nylon line
- to mark distances on the line
- to add weight so that the line sinks in water

Attaching the sphere
Prior to commencing the sphere measurements, a rope should be drawn beneath the hull from the first winch to the second and third winch before anchoring. Use this rope to pull the line from the first winch beneath the hull to the side with the second and third winches.

Attach the appropriate sphere, with affixed loop, to the three suspension lines, refer to figure 1. For the smaller spheres it may be necessary to add a weight to keep the sphere stable. This is done via a second line attached to the three suspension lines. The length of the line must be at least two pulse lengths, so that the echo from the additional weight does not interfere with the sphere echo. Immerse the sphere in a solution of dishwashing detergent and freshwater and lift it overboard by the fastened lines without touching it. The soap helps to eliminate air bubbles attached to the sphere.

Lowering the sphere
Lower the sphere beneath the vessel to the desired distance, for example 25 m, which is determined roughly by counting the swivels on each line.

In general, one should use sphere distances of 15 m or more for 38 kHz or higher frequencies. This in order to reduce the effect of pulse rise time and resolution in distance measurements on the calibration results. Software version 5.30 has corrected for these effects on the TS and s_A calibration.

Two further considerations in choosing the range are the transducer beamwidth and vessel geometry. The physical width of the beam, which increases linearly with range, should be sufficiently great so that the sphere echo is unaffected by the small, perhaps pendular movements to which it is inevitably subjected. The minimal range must also be convenient with respect to the vessel geometry. In particular, if the suspension lines do not hang freely, then control of the sphere may be hindered by friction or possible obstructions on the hull. Despite the number and variety of these considerations, it is seldom difficult in practice to find a suitable range which satisfies all of the above criteria.

Reference target.

Simrad supplies copper spheres designed as reference targets for the calibration of scientific sounders. Copper is selected because it is a metal which can be made electrolytically with high purity. The spheres are machined to the perfect spherical form with great accuracy, and a nylon loop is attached. Except for 12 kHz, 49 kHz and 50 kHz, the sphere diameter is different for each frequency in order to obtain a target strength with minimum dependence of temperature (K. Foote 1983). A curve showing the variation of the target strength follows each sphere. The curve for the 38 kHz sphere is shown below as an illustration.

Simrad copper spheres

Frequency kHz	**Diameter mm**	**TS sound at speed 1490 m/s dB**
12*	45.0	-40.4
18	63.0	-34.4
27	42.0	-37.9
38	60.0	-33.6
49*	45.0	-36.4
50*	45.0	-36.2
70	32.1	-39.1
120	23.0	-40.4
200	13.7	-45.0
710	10.3	-50.5

* same sphere

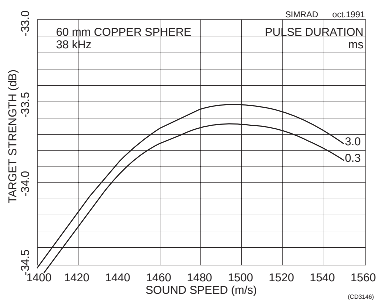


Figure 2 Target strength of a 60 mm copper sphere.

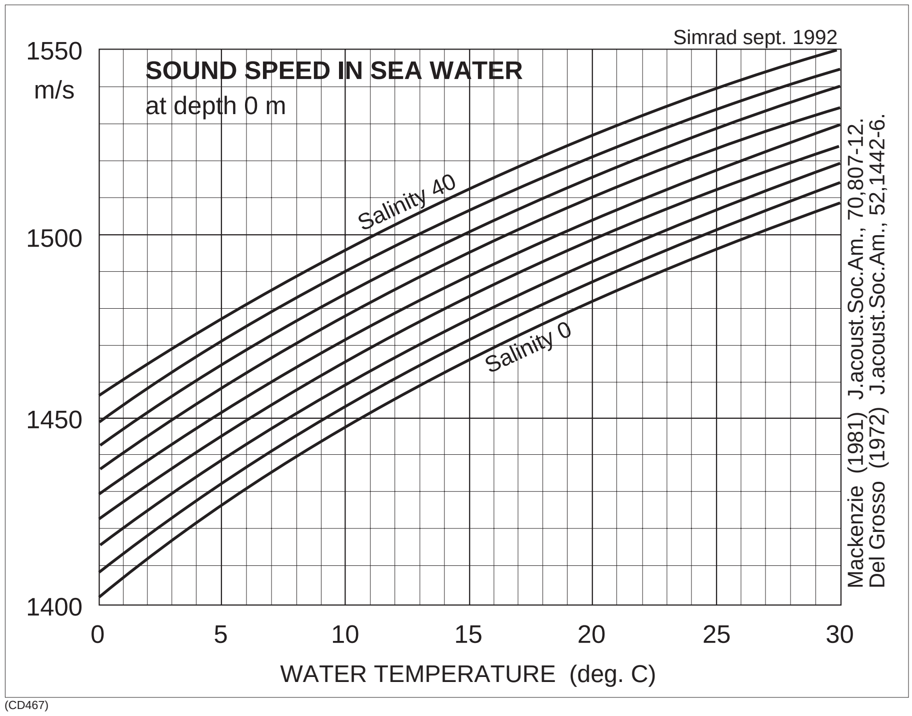


Figure 3 Sound speed in water.

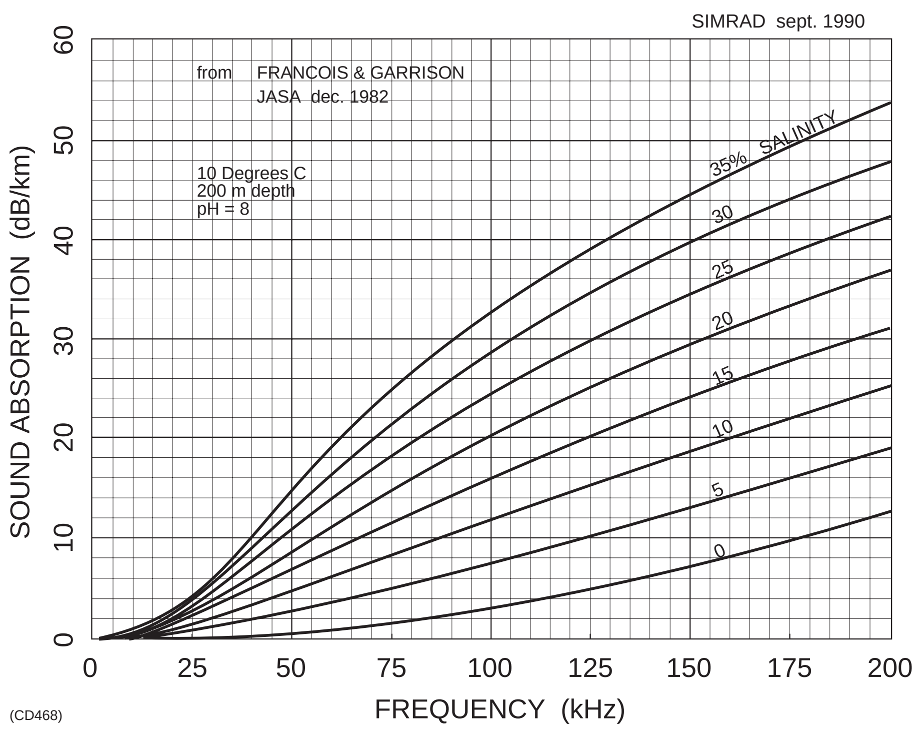


Figure 4 Sound absorption.

Centering of split beam

The purpose of this operation is to move the immersed, suspended sphere onto the acoustic axis of the transducer. First the echo sounder must be set so that the echo from the sphere is visible on the display.

Note that in the following procedures, references to transceiver 1, 2 and 3, and printer 1, 2 and 3, only apply to the EK 500 echo sounder. The EY 500 only uses one transceiver and one printer.

Select the Transceiver Menu and set:

Mode:	*Active*
Pulse Length:	*Medium*
Bandwidth:	*Wide*
Transducer Depth	*0.0 m*

Select the Operation Menu and set

Ping Mode:	*Normal*
Ping Interval:	*1.0 sec.*
Noise Margin:	*0 dB*

Select the Display/Echogram Menu and set

Range:	Select a range from the sea surface to well below the sphere
Range Start :	*0 m*
Auto Range:	*Off*
Bot. Range Pres.:	*Off*
Presentation:	*Normal*
Layer Lines:	*On*
Integration Lines:	*10 000*
TVG:	*40 log r*
TS Colour Min:	*-50 dB*

Select the Log Menu and set

Mode:	*Ping*
Ping Interval:	*100*

Select the Layer Menu and set

Super Layer:	*1*

Select the Layer Menu/Layer-1 Menu and set

Type:	*Surface*
Range: *Range Start:*	The layer must be wide enough to cover the sphere echo during the movements in the centering operation. Otherwise it should be as narrow as possible, in order to exclude disturbing fish echoes. Be sure that also the bottom echo as well as the trailing edge of the transmitter pulse and the echo from the additional weight are outside the layer.
Margin:	*0.0 m*
Sv Threshold:	*-80 dB*
No. of Sublayers:	*1*

The rest of the main layers should be turned off.

Select the TS-Detection Menu and set

Min. Value:	*-50 dB*
Min. Echo Length:	*0.8*
Max. Echo Length:	*1.8*
Max. Gain Comp.:	*6.0 dB*
Max. Phase Dev.:	*2.0*

The best value for the sound velocity (profile) should be set in the Sound Velocity Menu in order to keep the accuracy as high as possible for the calibration exercise.

If the sphere is in the beam an echo will now be seen as a steady line in the echogram. If the sphere furthermore is inside the -6 dB limit on the beam, the echo will show up as a dot on the TS detection window on the left-hand side of the screen. This horizontal projection makes it easy to see which way the sphere must be moved to reach the beam center. Movement of the sphere occurs by turning of the various hand winches, always one winch at a time and on specific command by the director of this procedure, who is guided by constant observation of the echo on the screen.

Centering of single beam

In a single beam system there are different methods to position the sphere in the centre of the beam. In this system the reference sphere, when detected as a single target, will always appear in the beam centre. Use the TS detection window to observe the TS value and adjust the position of the reference sphere for maximum TS value.

A second method is useful if a single beam transducer is located close to a split beam transducer. When the distance between the centre of the single and split beam transducers is known, the reference sphere can be positioned using simple geometry.

Choose the split-beam transducer in the Transceiver Menu, use the TS detection window and position the reference sphere in the centre of the beam as previously described (when the sphere is in the centre of the beam, both the *Angle Along* and the *Angle Athwart* in the TS window will be zero degrees).

Calculate the angle α by means of the information regarding the distance between the two transducers and the distance between the sphere and the transducers. Refer to figure 5.

$$tg\alpha = \frac{d}{r}$$

d = distance between single beam and split beam transducers
r = distance between the sphere and the transducers
α = refer to the figure

If, for example, the single beam transducer is located 0.6 m directly behind the split beam transducer, the sphere must be moved straight aft until the *Angle Along* shown in the TS detection window is the same as the calculated angle α. During the movement, the sphere must be kept at the same distance from the transducer.

The *Angle Along* corresponds to the calculated angle α and when these angles are equal, the sphere will have moved 0.6 m and be in the centre of the beam of the single beam transducer.

Now operate the system with the single beam transducer and read the TS value in the TS detection window. To check that the sphere is in the centre of the beam, move the sphere slightly in the athwartships and fore-and-aft directions and check for increasing or decreasing TS value.

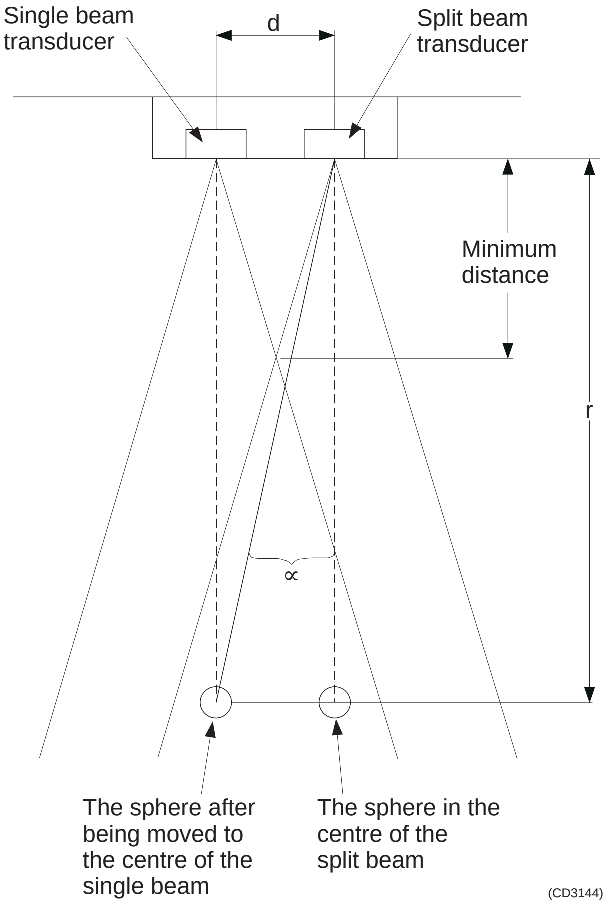


Figure 5

The Scope mode may be useful during this process as well. The scope plot starts at the beginning of the super layer, and the horizontal axis contains 200 depth samples. Accordingly, this depth scale is different for the different frequencies. Check that the sphere is well within the super layer. Select the Test Menu, *Scope* and a dynamic range for the plot (50 dB). Then select the highest amplitude value to be included in the plot (-50 dB). The sphere echo should now appear on the scope plot. Reduce the dynamic range to give a high vertical resolution and adjust the highest amplitude to give a convenient plot where the peak sphere echo reaches the horizontal centre line on the scale. Then move the sphere in the transversal and longitudinal directions until the maximum amplitude position has been found.

Use the TS detection window for single beam to read maximum TS value.
Look at the echogram and check that you have, from the top:

- transmitter pulse
- upper layer limit (red line)
- sphere echo
- lower layer limit (red line)
- echo from the additional weight (if used)
- bottom echo

all well separated, and no other echoes within the layer limits.

TS-measurement

Select the TS-Detection Menu to get the horizontal projection window. With the sphere in the center of the beam, the TS compensated and the TS uncompensated should be identical. These values are read on the screen underneath the horizontal projection window. If there is a small difference use the TS compensated value as the measured TS value. It is recommended that the measured TS value is logged together with other important information. A recommended form is attached at the end of this document.

If the measured TS value differs from the known TS value of the sphere, then calculate a new TS transducer gain:

$$\text{New transd. gain} = \text{Old transd. gain} + \frac{\text{TS measured} - \text{TS sphere}}{2}$$

Select the new *TS Transducer Gain* in the Transceiver Menu and check that the measured target strength is correct.

In software version 5.20 and higher, TS values have been corrected for TVG inaccuracies because of the sample intervals and the pulse rise time.

s_A - measurement

The calibration of the TS-measurement described in the previous paragraph is the primary calibration and it will in many cases be a sufficient calibration. The TS-measurement, however, is based on the peak value of the echo samples in the sphere echo, whereas the s_A-measurement is based on integration (averaging) of the echo samples. The received echo may have a smoothed rise and decay. Therefore the algorithm for calculation of s_A in the sounder uses an effective pulse length rather than the nominal pulse length. A test, and if necessary, a calibration of the s_A calculation may be carried out according to the following procedure.

Check the cable connection to colour printer-1.
Switch on colour-printer-1.

Select the Printer1 Menu and set

Integrator Tables:	*Number of the transceiver in use (if EK 500)*
Echogram:	*Slave*

The echogram recording will then be similar to the one at the display. Read the measured s_A-value, the red number in the integrator table after each log interval. Calculate the theoretical s_A-value as follows:

TS sphere = target strength of the sphere

σ_{bs} = backscattering cross section of the sphere

$\sigma_{bs} = 10^{\text{TS sphere}/10}$

r = distance between the transducer and the sphere
(read from the display screen, underneath the horizontal projection window).

Ψ = equivalent 2-way beam angle
(from the measurement data delivered with the transducer)

$\Psi = 10^{\text{dB-value} / 10}$

$$s_A\,(\text{theory}) = \frac{4\pi r_0^2 \cdot \sigma_{bs} \cdot (1852\ \text{m/nm})^2}{\Psi \cdot r^2}$$

where r_0 = 1 meter is the standard reference distance for backscattering.

If the measured s_A-value differs from the theoretical value, this can be corrected by changing the *S_v Transducer Gain* in the Transceiver Menu. Calculate a new transducer gain:

$$\text{New transd. gain} = \text{Old transd. gain} + \frac{10 \log (s_A(\text{measured})/s_A(\text{theory}))}{2}$$

Enter the S_v transducer gain in the Transceiver Menu, and the measured s_A-value will be correct.

The calibration report form at the end of this appendix may be used for recording calibration conditions and results.

3 THE LOBE CALIBRATION PROGRAM

3.1 UNPACKING AND STARTUP

This software package greatly simplifies the task of determining the optimum transducer pattern parameters to be used in the EK 500/EY 500 Transceiver Menu. The program runs on IBM PC/XT/AT's and compatibles. It is strongly recommended to have a mathematics coprocessor (8087/80287/80387) installed in the computer to speed up the estimation and plotting algorithms.

This software is distributed free of charge to all Simrad EK 500/EY 500 customers. A self-extracting archive contains
- C source code files
- makefile for automatic compilation/linking
- the executable lobe calibration program
- example transducer measurement data files
- archive program with user's manual
- this manual (manual.doc)

The C source code was compiled with a Borland Turbo C++ 1.01 compiler.

The procedure for unpacking the archive files is straightforward. Insert the Simrad distribution diskette in the A drive. Create an empty directory on the hard disk and copy the archive file to the empty directory. Move to the new directory and execute the self-extracting archive program.

```
mkdir lobedir
copy a:*.* lobedir
cd lobedir
lo950117.exe (or older version with different date)
```

After completion of the archive program the "lobedir" directory contains all the unpacked files.

To start the lobe calibration program, type

```
lobe.exe
```

at the DOS prompt. The function keys F1 to F5 select different operational menus.

F1. To quit the lobe calibration program.

F2. Serial port 1 is used for communication with the EK 500. For the EY 500 connect to the serial line on the PC and set /Utility/Com1/Com2 Switch = On)

This menu sets the communication parameters. The RS232 cable coupling diagram is shown on the computer display.

F3. To record the reference target detections from the EK 500/EY 500 into a measurement data file. Horizontal hit position and vertical target depth are displayed.

A simulation mode is available for demonstration and training purposes by starting the lobe calibration program with an option parameter
lobe.exe -s

F4. To view the true transducer pattern. A two-dimensional polynomial of the fourth degree is least square fitted to the measured data points and displayed. Please observe that the polynomial model has more freedom to adjust to the measured data points than the EK 500/EY 500 internal transducer model. Hence, the polynomial model should be used to view the true transducer pattern.

F5. The internal transducer model of the echo sounder is least-square fitted to the measured data points and displayed. The optimum pattern parameters are automatically loaded into the echo sounder using the remote control commands via the RS232 connection.

3.2 OPERATING PROCEDURE

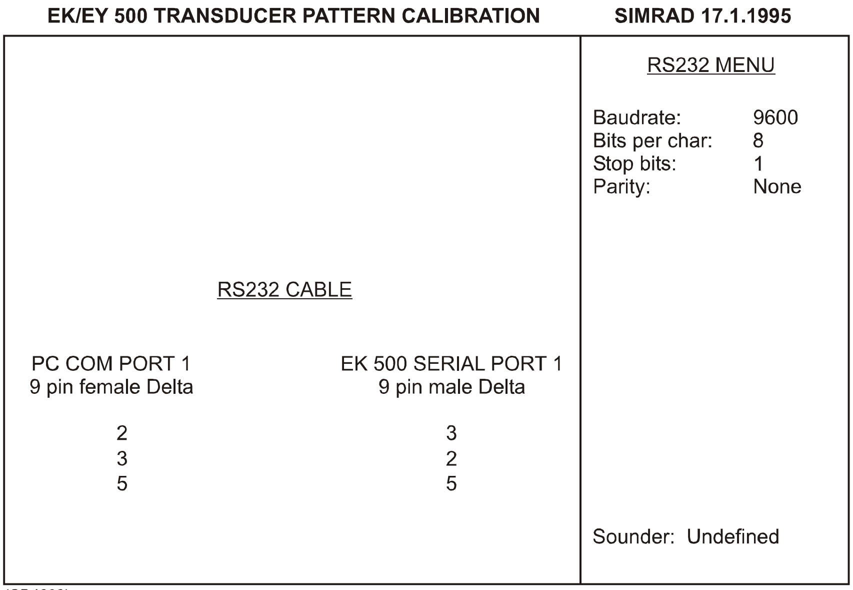
Connect an RS232 serial line cable between the PC and Serial Port 1 on the EK 500 and the serial line on the PC for the EY 500.

Type F2. The plug connections will then be given on the computer display.

Check that the echo sounder Serial/USART Menu has settings corresponding to those given in the LOBE RS232 Menu. Refer to figure 6.

Switch on the echo sounder and select the Serial/Telegram Menu and set *Remote Control* to *On*. Follow the instructions previously given for Centering of split beam until the sphere appears as a steady line in the echogram and the sphere is positioned in the centre of the beam and at a suitable distance from the transducer.

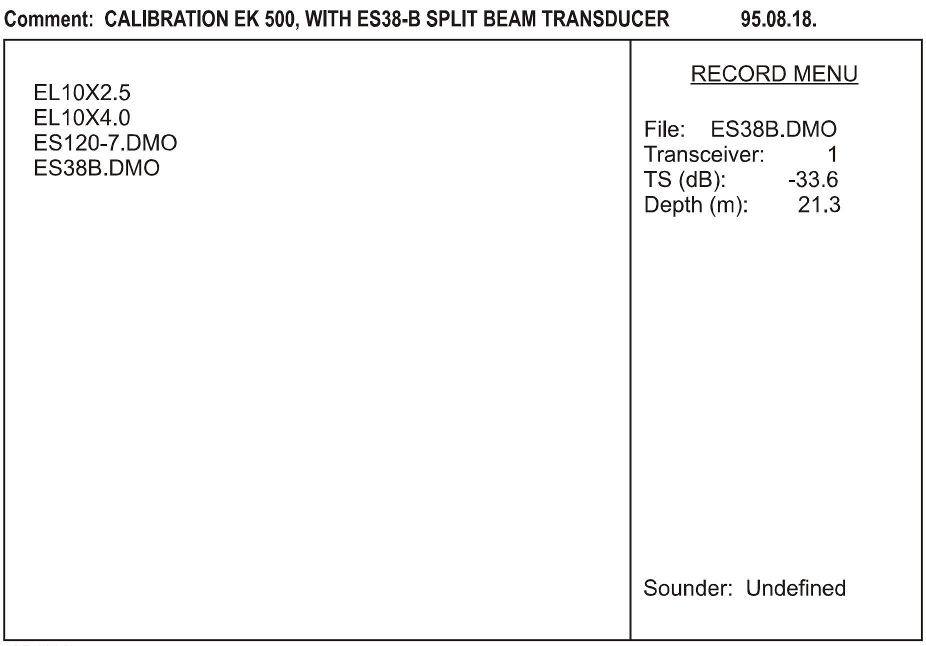
Switch on the PC and start the LOBE program. Then the LOBE program will enter necessary menu settings in the echo sounder and read necessary parameters from same. While the sounder is operating, check that the RS232 serial line connection is active by typing F2.



(CD4929)

Figure 6

Type F3. The display will show previously saved calibration files. The cursor will appear at the end of the comment file on top of the display.
Erase the comment string and enter your comments concerning the present calibration. In the Record Menu you have to fill in a new *File Name* and *Transceiver Number* according to the setting in the sounder (if EK 500). The transceiver number is selected by means of the horizontal arrow keys. The correct TS for the calibration sphere according to actual sound velocity has to be entered in addition to the Depth reading from the TS Menu provided that the *Transducer Depth* has been set to *0.0 m*. Refer to figure 7.



(CD4930)

Figure 7

The LOBE program will set up "windows" around TS value and Depth. The TS window is ±4 dB and the Depth window is ±10%. TS samples outside the windows will be rejected. When starting the calibration, check that the measured TS value is well within the window. If it is close to the limit, you may, when moving the sphere, easily end up with TS values outside the window that will be rejected. To avoid this you should readjust the *TS Transducer Gain* in the echo sounder's Transceiver Menu until the reading is closer to the correct TS value. Then the LOBE program has to be restarted by typing CR/LF and then F3. This is because the LOBE program has to collect the new settings from the echo sounder. The Depth window is shown as the green part of the red bar on the left hand side of the PC display. The present depth of the reference sphere is shown as the white dot on the right hand side of the bar. Refer to figure 8.

Then move the reference sphere slowly to collect TS data sets until the file contains sufficient number (>100) of samples evenly distributed inside the 4 quadrants of the beam pattern. The present or last position of the sphere inside the beam is shown in white colour (black) and the recorded samples are blue (grey). The recorded number of Data Sets is shown. When the file is completed, stop collecting data by typing CR/LF.

If the TS of unwanted objects like fish is recorded, note the sample numbers when these are recorded. Before processing the recorded data, use an editor to delete the data recorded from these unwanted echoes. They can be located using the sample numbers noted, obviously incorrect TS or/and Depth values appearing incidentally.

When suspect data has been removed, type F4 to check the true transducer pattern. If this appears to be non-consistent with the expected shape or with considerable offset values or other anomalies, the possible cause has to be revealed before the calibration can be completed. The reason may be the transducer or the transceiver unit.

If acceptable data has been recorded, type F5. The processing of the collected data will start and the number of iterations is shown at the lower end of the Fit Menu. When reaching approximately 50 iterations, the processed data will remain even and the processing can be stopped by typing CR/LF. In the Fit Menu there is a Relative Angle given in % (° in old versions). 150 % means all accepted samples are being used in the calculation. If the operator would like to check the beam pattern for a reduced angle, decrease the setting by using the horizontal arrow keys. Reducing to 100 % the calculation will only use samples inside the -3 dB circles.

In the Fit Menu the rms deviation between calculated beam pattern and the collected data sets will be given as well as the minimum and maximum deviation and where these data sets are recorded in the file. The max. and min. values are shown by a red and a blue cross in the polar diagram. The recorded max. and min. samples should be removed by using the editor if the deviations are more than approx. 1 dB. Note the line numbers to locate these unwanted data. All the remaining data sets are shown in the polar diagram by red and blue dots. The red ones are those above the calculated beam pattern, the blue are those below. A cut through the beam can be shown for 0, 45, 90 and 135 degrees by typing F1, F2, F3 or F4. Refer to figure 9.

The final calibration data for TS Gain, Beam and Offset values are calculated and shown in the Fit Menu. These data should preferably be logged in the recommended form at the end of this document.

By typing CR/LF one more time, the PC will ask if the operator wants to "Copy best fit parameters to EK 500 (y/n) ?". When typing y, the calculated data will be entered into the Transceiver Menu. If the echo sounder is already in the Transceiver Menu, leave this and enter the same menu again to have the new settings displayed.

When the reference sphere is located in the centre of the beam after the calibration has been completed, the TS value in this position may be a little higher than the correct TS. This is more perceptible using old versions of the LOBE program with a little bit different algorithm.

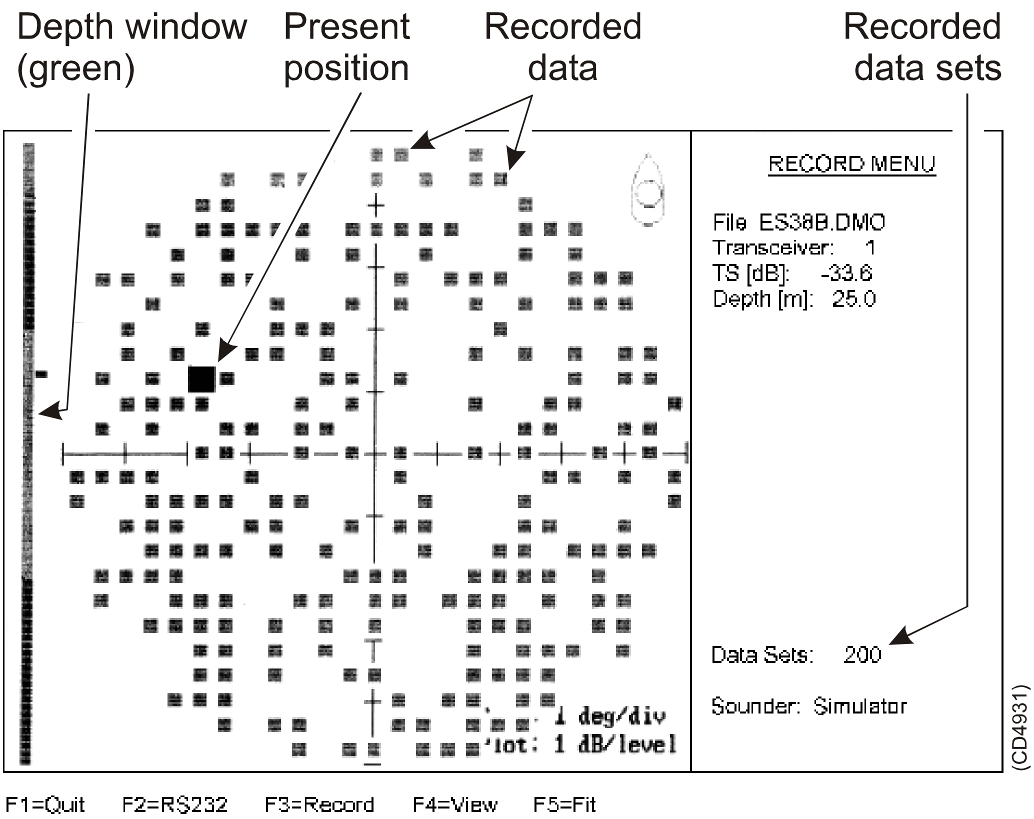

Depth window (green)
Present position
Recorded data
Recorded data sets
RECORD MENU
File ES38B.DMO
Transceiver: 1
TS [dB]: -33.6
Depth [m]: 25.0
Data Sets: 200
Sounder: Simulator
1 deg/div
1 dB/level
F1=Quit F2=RS232 F3=Record F4=View F5=Fit
(CD4931)

Figure 8

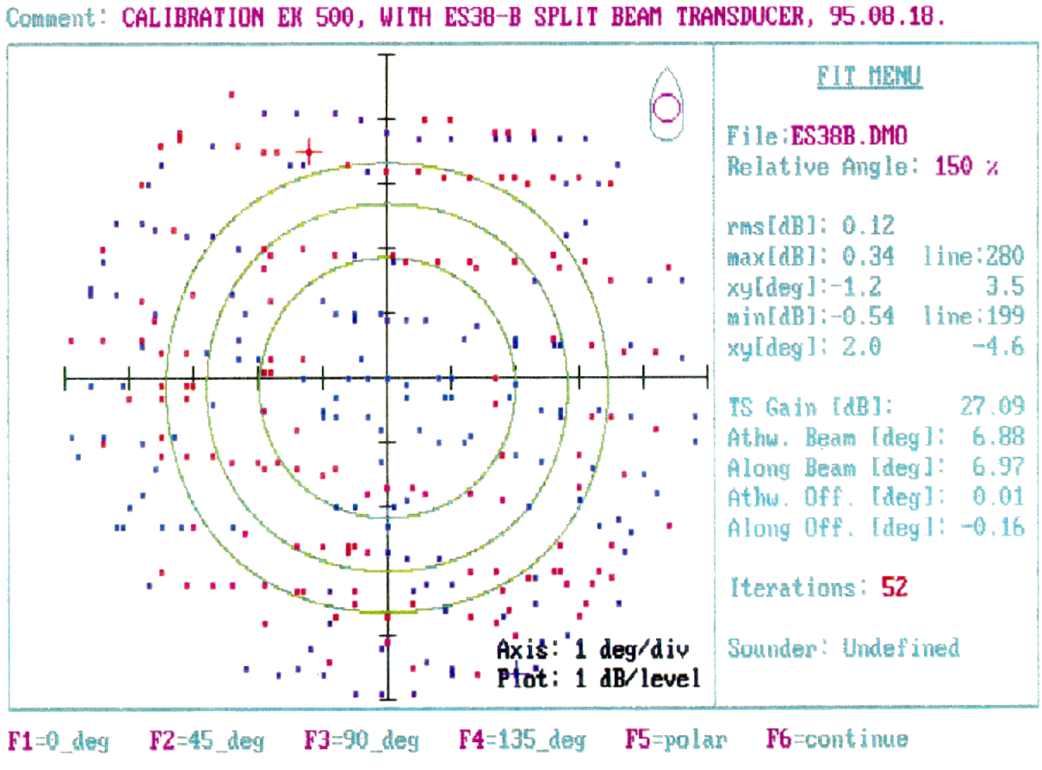

Comment: CALIBRATION EK 500, WITH ES38-B SPLIT BEAM TRANSDUCER, 95.08.18.
FIT MENU
File:ES38B.DMO
Relative Angle: 150 %
rms[dB]: 0.12
max[dB]: 0.34 line:280
xy[deg]:-1.2 3.5
min[dB]:-0.54 line:199
xy[deg]: 2.0 -4.6
TS Gain [dB]: 27.09
Athw. Beam [deg]: 6.88
Along Beam [deg]: 6.97
Athw. Off. [deg]: 0.01
Along Off. [deg]: -0.16
Iterations: 52
Sounder: Undefined
Axis: 1 deg/div
Plot: 1 dB/level
F1=0_deg F2=45_deg F3=90_deg F4=135_deg F5=polar F6=continue

Figure 9

4 NOISE MEASUREMENTS AT SEA

The final result of the noise measurements should be a plot of the acoustic noise in front of the transducer versus vessel speed. This plot may be compared with similar plots for other transducers on the same vessel, or plots from other vessels, and may thus serve as an evaluation of the transducer location and the vessel noise radiation. In addition, the noise plot may be a guide in choosing the vessel speed during acoustic surveys. Since the propeller pitch and revolutions per minute influence the noise level, it is important to determine the most favourable combination of these factors. Normally a slow rotation and a high pitch give the lowest noise.

The noise measurements should take place at least one nautical mile off shore, far from other ship traffic and and with favourable weather conditions. It is preferable that the water depth is 200 m or more. The noise should be measured at different vessel speeds, from 0 to maximum speed, with steps of 2 knots. The vessel's course must be kept steady during these measurements.

With the settings specified below, the printer will produce an echogram and an integrator table. With some experience it should be possible to reveal the noise source from looking at the echogram. Typical sources may be propeller cavitation, small damages on the propeller blade, the machinery, or thermal noise. It is a good routine to save the echogram with the integrator table for comparison with later recordings.

Select the Operation Menu and set:

Ping Mode:	*Normal*
Ping Interval:	*0.0*
Transmit Power	*Normal (only for the EK 500)*
Noise Margin:	*0 dB*

Select the Transceiver Menu/Transceiver-1 Menu (if the transceiver to be tested is transceiver No. 1) and set:

Mode:	*Passive*
Pulse Length:	*Medium*
Bandwidth:	*Wide*

Select the Transceiver Menu/Transceiver-2 Menu and set (only for the EK 500):

Mode: *Off*

Select the Transceiver Menu/Transceiver-3 Menu and set (only for the EK 500):

Mode: *Off*

Select the Log Menu and set:

Mode: *Ping*
Ping Interval: *200*

Select the Display Menu and set:

Echogram Speed: *1:1*
Echogram: *1*

Select the Display Menu/Echogram-1 Menu and set:

Range: According to table below
Range Start: According to table below

Frequency (kHz)	Range	Range Start
18	5000	0
38	1000	100
120	250	0
200	200	0

Auto Range: *Off*
Bot. Range Pres. *Off*
Presentation: *Normal*
Layer Lines: *On*
TVG: *20 log R*
Sv Colour Min. *-80 dB*

Select the Printer-1 Menu and set:

TS Distribution: *Off*
Integrator Tables *1*
Echogram: *Slave*

Select the Layer Menu and set:

Super Layer: *1*

Select the Layer Menu/Layer-1 Menu and set:

Type:	*Pelagic*
Range (layer thickness L)	*See table below*
Range Upper:	*See table below*
Sv Threshold	*-100 dB*
No. of Sublayers:	*1*

Frequency kHz	Range L m	Range Start m	2TL dB
18	50	3975	96
38	20	990	80
120	10	195	61
200	5	147,5	59,5

Range settings and transmission loss for different frequencies

Start the noise - speed trial with the vessel in a fixed position. Make a short echogram recording and an integration table for the same interval. Print a marker line when starting the recording and give the line a number that at the same time is logged in the noise-speed report form at the end of this document.

Print a second marker line at the end of the recording, connect the propeller and increase the speed to 2 knots. When the vessel has reached a stable speed, make a new echogram recording interval and integration table for the same interval. Continue the same procedure at 2-knot intervals until reaching maximum speed. Use marker lines to separate the different intervals. When at maximum speed, disconnect the propeller as quick as possible and print marker lines for each 2 knots as the speed decreases towards 0.

If the noise level quickly decreases towards the level at 0 knots as soon as the propeller has been disconnected, this means that the noise is generated by the propeller. If the recording at decreasing speed is more or less equal to the same noise level at increasing speed, the cause is probably flow-noise.

If the increase in level is propeller noise and this substantially reduces the performance of the sounder, repeat the tests with different combinations of pitch and propeller speed if possible, to find the most favourable conditions.

When making echogram recordings at different speed levels, select the Test Menu/Transceiver and read the noise power P_N re 1 W. Enter readings in the same form at the end of this appendix.

When the trial has been completed, the corresponding noise level, NL dB re 1 μPa can be calculated for both the recording procedures. The results from the two procedures might differ somewhat because of the different ways they are measured. The S_A method gives the average echo level from a volume of water during a specified time interval. The P_N method is from one individual power sample in each ping.
The equations for calculating from recorded data to NL is given below.

From S_A: (based on the sonar equation)

$$NL = S_i + 10 \cdot \log (P_{TX} \cdot S_A \cdot T / Z \cdot L) - 2TL + 10 \log \Psi - 75$$

NL	=	Noise level	dB re 1 μPa
S_i	=	Transducer transmitting response	dB re 1 μPa per A
P_{TX}	=	Transmitter power	W
Z	=	Transducer impedance	ohm
2TL	=	Two-way transmission loss	dB
L	=	Layer thickness	m
10 log Ψ	=	Equivalent two way beam angle	dB
T	=	Transmitter pulse length	msec

S_i , Z , and 10 log Ψ is from the data sheet for the specific transducer
For split beam transducers Z is for all four quadrants in parallel
P_{TX} and T is from the sounder specifications 2TL and L from the table on page 26.

From P_N:

$$NL = P_N - 20 \log \lambda - G + 192.8$$

λ =	wavelength = c/f	
c =	speed of sound = 1500	m per sec.
f =	frequency	Hz
G =	transducer gain	dB
	Read G in the Transceiver Menu/*S_V Transducer Gain*	

This noise level NL is comparable with the previous measurements on the EK 400 when the EK 400 calibration procedure was followed.

The theory for the derivation of the above formula for NL from P_N is given here, now using linear quantities (not dB):

P_N is received noise power	W
I_N is plane wave sound intensity in front of the transducer	W/m^2
A is the effective receiving area of the transducer	m^2

$P_N = I_N \cdot A$
G is the transducer gain = $4\pi A/\lambda^2$

n is the plane wave sound pressure in
front of the transducer Pa
$n^2 = I_N \cdot \rho c$
ρ is water density = 1000 kg/m^3
c is the speed of sound = 1500 m/s
NL = 20 log n + 120 dB re 1 μPa
120 dB is introduced for conversion from Pa to μPa

For the reason of documentation it is recommended to record one scope plot at survey speed.

Select the Printer-1 Menu/Echogram-1 Menu and set:

Presentation: Scope.

When the scope printout has started, set:

Presentation: Normal

Repeat the measurement for transceiver 2 and 3 (if installed).

References

ICES Cooperative Research Report 144:
Calibration of acoustic instruments for fish density estimation: A practical guide.
ICES, Palægade 2, 1261 Copenhagen K, Denmark

ICES Fish Capture Committee 1981/B:20
Improved calibration of hydroacoustic equipment with copper spheres. By Foote, Knudsen, Vestnes, Institute of Marine Research, Bergen and Brede, Nielsen, Simrad Subsea Horten, Norway.

Journal of the Acoustical Society of America, March 1983.
Maintaining precision calibrations with optimal copper spheres By Ken Foote.

Ref. no	Revolutions		Propeller pitch	Vessel speed	Measured S_A	NL from S_A	Test menu NOISE	NL from test menu
.	Engine r.p.m.	Propeller r.p.m.		Knots	m^2/nm^2	dB re. 1 μPa	dB re. 1 W	dB re. 1 μPa
0		0		0				
1				Increasing				
2				2				
3				Increasing				
4				4				
5				Increasing				
6				6				
7				Increasing				
8				8				
9				Increasing				
10				10				
11				Increasing				
12				12				
13				Increasing				
14				14				
15				Increasing				
16				16				
17		Disconn.						
18		0						
19		0						
20		0						
21		0						
22		0						
23		0						
24		0						

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CALIBRATION REPORT EK 500 / EY 500

VESSEL:.. DATE:...
PLACE:... EK/EY 500 SERIAL NO:...
TRANSDUCER TYPE:......................... SERIAL NO.:.................... FREQUENCY:.................. KHZ
WATER TEMP:..................°C SALINITY:...................% SOUND VELOCITY:............M/SEC.

Ping Interval	1	1	1	sec.
Absorption Coefficient				dB//km
Pulse Length	SHORT	MEDIUM	LONG	
Bandwidth				
Maximum Power				W
Transmit Power				
Angle Sensitivity Alongship (fore and aft)*				
Angle Sensitivity Athwartships*				
TS of Sphere				dB
Default TS Transducer Gain				dB
Measured TS				dB
Calibrated TS Transducer Gain				dB
Calibrated TS				dB
Default 2-Way Beam Angle				dB
Transducer data 2-Way Beam Angle				dB
Measured Distance Transducer - Sphere				m
Default Sv Transducer Gain				dB
Theoretical s_A				m^2/nm^2
Measured s_A				m^2/nm^2
Calibrated Sv Transducer Gain				dB
Calibrated s_A				m^2/nm^2
Default -3dB Beamwidth Along. *				degrees
Default -3dB Beamwidth Athw. *				degrees
Calibrated -3dB Beamwidth Along.*				degrees
Calibrated -3dB Beamwidth Athw.*				degrees
Alongship (fore-and-aft) Offset*				degrees
Athwartships Offset*				degrees

* Valid for split-beam transducers only

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ASCII CHARACTERS - HEXADECIMAL CONVERSION TABLE

P2262E / 859-043869 / 4AA005

This document contains a conversion table to assist you with converting characters from ASCII to hexadecimal and back.

	0X	1X	2X	3X	4X	5X	6X	7X
X0	NUL	DLE	SPACE	0	@	P		p
X1	SOH	DC1	!	1	A	Q	a	q
X2	STX	DC2	"	2	B	R	b	r
X3	ETX	DC3	#	3	C	S	c	s
X4	EOT	DC4	$	4	D	T	d	t
X5	ENQ	NAC	%	5	E	U	e	u
X6	ACK	SYNC	&	6	F	V	f	v
X7	BEL	ETB	’	7	G	W	g	w
X8	BS	CAN	(	8	H	X	h	x
X9	HT	EM	)	9	I	Y	i	y
XA	LF	SUB	*	:	J	Z	j	z
XB	VT	ESC	+	;	K	[	k	{
XC	FF	FS	´	<	L	\	l	|
XD	CR	GS	-	=	M	]	m	}
XE	SO	RS	.	>	N	^	n	~
XF	SI	US	/	?	O	_	o	DEL

Document revisions

Rev	Documentation department		Hardware/Software Design		Project/Product Management	
	Date	Sign	Date	Sign	Date	Sign
A	01.11.90	-				
B	15.03.96	-				
C	15.04.96		15.04.96		15.04.96	

Revisions:

Rev.A First edition.
Rev.B Document updated to Simrad standards.
Rev.C Document minimized to fit on two pages.

Simrad EK 500
Operator manual

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